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SOME COMMON INDIAN BIRDS.

No. 29. THE INDIAN LONG-TAILED NIGHTJAR (*CAPRIMULGUS MACRURUS ALBONOTATUS*).

BY

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THE Nightjars form a small family of birds of which eleven species, representing fourteen named forms contained in two genera, occur within Indian limits. One species, the Great-eared Nightjar (*Lyncornis cerviniceps*), occurs in Burma and Travancore and is readily distinguishable by the presence of tufts of feathers just above and behind the ear-coverts, but all our other Indian Nightjars belong to the typical genus *Caprimulgus*, without ear-tufts, and are very much alike, all being brownish or yellowish-grey mottled with darker and lighter spots. In habits, as in general appearance, they are all very similar, resting during the day-time on the ground amongst vegetation or stones or clods of earth, and appearing on the wing only at dusk, when they hawk about for insects which they catch either on the wing by means of their large mouth, which can be opened very widely, or on the ground. They are rarely seen in the day-time, when they keep quite motionless, squatted on the ground, and are readily passed over as a clod of earth, but are commonly seen on the wing in the evening or may be found on roads catching dung-beetles attracted to cattle-droppings.

As in some other groups of birds, the typical Nightjars have a comb-like formation on the inner side of the long middle-toe, but the use of this structure appears to be unknown although it is supposed to be of use in cleaning the beak and the long rictal bristles from the hooked claws of beetles and from the scales of moths which have been caught in the mouth. These birds have also strongly developed rictal bristles which doubtless assist them to obtain insect prey on the wing.

Their noiseless flight is very characteristic and more resembles that of a gigantic moth than that of a bird. It consists of a few quick flappings of the wings alternated with rapid and complicated glides and wheels through the air with wings widely extended. Sometimes the tips of the long wings are brought together above the back with an audible smack. Its position at rest also makes it easy to place a bird as a Nightjar, as it squats down with its whole body on the resting surface; also when a Nightjar perches on a branch, it sits on it lengthwise, and not across it as other birds do.

Their food consists entirely of insects, largely moths and beetles, captured both on the wing and on the ground. They may therefore be considered as useful birds but hardly occur in sufficient numbers, as a rule, to do very much good. It should be noted, however, that the quantity of moths captured and devoured by a single bird is astonishingly large.

As already noted, all the Nightjars look very much alike, at least when seen at large after night-fall. The Common Indian Nightjar (*Caprimulgus asiaticus*), distinguished by having distinct but narrow black streaks on the back, in combination with an almost

Common Indian Nightjar (*Caprimulgus asiaticus*); Left foot and head.
(After Blanford, *Fauna of British India*, Birds, Vol. III, p. 72.)

naked tarsus, occurs commonly throughout most parts of the Plains of India, Ceylon and North Burma. It is found in open and cultivated country, groves, gardens and non-forested areas generally and is often seen near habitations. It occurs commonly in the larger gardens of Calcutta and is sometimes known as the "Ice-bird," because its cry, which is constantly heard at night, is like the sound made by a stone skimming over the frozen surface of a pond, the note being repeated slowly at first and then more quickly.

In North Bihar the Common Nightjar seems to be replaced by the Indian Long-tailed Nightjar (*Caprimulgus macrurus albonotatus*), shown on our Plate, which is very similar to the Common Nightjar but rather larger in size, and may be distinguished by having the tarsus feathered throughout. It is found throughout the Plains from North-West India to Assam, extending into the lower ranges of the Himalaya, wherever suitably wooded areas occur, but in the summer months it ascends higher up the Hills, having been noted at Bhimtal and Masuri.

Regarding its habits, Stuart-Baker, writing on the Birds of North Cachar, gives the following interesting note, which may be quoted *in extenso*: -"My house is built on a hill, the garden on the steepest side coming up to the very brow of the steep, almost precipitous grass slope, leaving room only for a narrow foot-path for the servants and hill-people just outside the fence. This path-way is the favourite haunt after dusk of this fine Nightjar and I, seated motionless on the bank, often have had them approach me within a few feet, so near indeed that I have more than once tried to catch them with a short butterfly-net. I believe it is not at all generally known how much these birds feed on the ground, but I have constantly observed them so feeding, and butterflies or other large *dead* insects which were placed near their favourite resting-places were greedily eaten by them. Their movements on the ground are stronger and quicker than might be expected, judging from the formation of their feet, and they *run* in exactly the same manner as do martins and swallows when collecting mud for their nests.

"A very remarkable trait in this bird is the fact that the female will accept the advances of more than one male, but, remarkable as it is, it is undoubtedly the fact, for on one occasion I was a witness of it nor could there be any mistake, for both males were present at the same time and within three yards of me.

"The actions of the young are very peculiar; tiny mites, still blind—their eyes do not seem to open till the seventh day—will, when first discovered or when they hear a heavy tread near them, lie flat on the ground, their colour closely assimilating with the dead bamboo leaves or other material on which they lie; should, however, the danger of discovery become very imminent, they will crawl under the leaves and hide from sight altogether."

Like other Nightjars, the Indian Long-tailed Nightjar makes no nest, laying its eggs on the bare ground, usually in some sheltered situation. Pairing begins in March and eggs are usually laid by the end of this month or early in April in the Plains, or a little later in the Hills. The number of eggs laid seems to be always two. The eggs vary somewhat in colour, from creamy-white to salmon or fleshy clay-colour, blotched and speckled with reddish-brown, and measure about 30 by 22 mm. The hen bird sits very closely on her eggs, so that she may almost be trodden upon before flying off. Speaking of Nightjars in general, Newton remarks:—"So light is it that the act of brooding, even where there is some vegetable growth, produces no visible depression of the grass, moss, or lichens on which the eggs rest, and the finest sand almost equally fails to exhibit a trace of the parental act. Yet scarcely any bird shows greater local attachment and the precise site chosen one year is almost certain to be occupied the next."

The call of this species is quite different from that of the "Ice-bird," consisting of the sounds "*chounk chounk*" repeated at intervals, and may be compared to the sound made by striking a plank with a hammer. When on the wing it also utters a low chirping cry.

The Nightjars are also known as Goat-suckers, from a popular idea that they suck the milk of goats: it is hardly necessary to say that they do nothing of the kind. Vernacular names applied to

Nightjars generally in India are *Chippak* or *Chappa*, *Dab-chiri* or *Dabbak* (an appropriate name, derived from *dabna*, to crouch), and *Andha-chiriya* (blind bird). Other appropriate names are *Kappa-pitta* (frog bird, Telegu) and *Pathekai* (roadside-bird, Tamil). In Burmese it is *Hnet-pyin*.

CROP REPORTING IN INDIA.

BY

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Director of Statistics.

IT is proposed to give in the present article some general information as to the methods of framing estimates of outturn in crop forecasts in India as well as in the United States of America and Egypt.

THE PRESENT METHOD IN INDIA.

The framing of an estimate of the outturn of a crop depends on *three factors*—the area, the standard normal outturn per acre, and the condition estimate.

As regards *area*, there exists in the villages of most provinces an agency capable of reporting the acreage of crops with great accuracy, wherever fields have been mapped and surveyed. There are certain tracts (mostly in Bengal, Bihar and Orissa, some parts of Madras, etc.) which consist chiefly of permanently settled estates, lands held on privileged tenures, and unsurveyed areas, where, owing to the absence of trained village establishments, the estimates of area are more or less conjectural, but these estimates are revised from time to time by careful comparison with the conditions prevailing in those adjoining areas of a similar character for which accurate information is available and by means of such special enquiries as may be possible. Estimates of areas under mixed crops are also more or less conjectural as they are based on formulæ prescribed by provincial authorities.

The second factor, *the normal outturn per acre*, is briefly defined to be "the average yield on average soil in a year of average character". This normal or average outturn does not necessarily correspond with the average figure for a series of years, which is an arithmetical abstraction and may possibly never occur. The

Agricultural Department in each province maintains a statement[1] of the normal yields per acre of crops (under the two major heads of "irrigated" and "unirrigated") of lands of average quality in each district. In order to test the accuracy of these standards of normal yield and to revise them, if necessary, a system of crop-cutting experiments is in force in all the provinces. Under this system plots of land of average quality are selected, and the crops grown on them are cut and weighed in the presence of responsible officers of the district staff or of the provincial Agricultural Department. These experiments are carried out every year in respect of all the principal crops and in accordance with the rules specially framed by provincial authorities. The results of the experiments are reported to the head of the provincial Agricultural Department, who, on a careful scrutiny of all the reports and after such further investigations as he may deem necessary, revises or verifies the standards previously adopted for the districts or the province. This revision is ordinarily made once in five years.

The third factor –*the condition estimate*– is the fraction representing the relation of the crop reported on to the normal crop per acre. In many parts of India, the cultivators estimate the crop outturn in annas or sixteenths. They take a certain number of annas to represent the normal outturn and estimate the outturn of the year of report as so many annas higher and lower than the normal. There is, however, no fixity in the standard of anna notation; and the number of annas taken to represent a normal outturn varies between 12 to 16 in some tracts 16 annas represent a normal crop, while in others the same term denotes a bumper crop. Consequently the anna estimate of one tract is not always amenable to comparison or combination with that of another tract. There is another system (known as the American system) of expressing the condition of a crop. Under this system, 100 is taken to denote a normal crop and the estimated outturn of the year of report is stated to be a percentage of that crop. In 1897, a question arose as to whether the "anna notation" or the "American

[1] *Quinquennial Report on the Average Yield per acre of Principal Crops in India for the period ending* 1921–22.

system" should be used in making crop estimate, and it was strongly urged upon the Government of India that, as the cultivators and the village officers entrusted with the duty of collecting data for crop reports were mostly accustomed to the Indian system (the anna notation), the adoption of any other system would tend to confuse the estimate. Local Governments and Administrations were, therefore, permitted to adopt such scales of notation as might be suited to the local conditions and usages, the object being to secure the returns in terms of a normal crop. But as the "anna standard" thus adopted would not possess any fixed or uniform value, it was laid down that in the published forecasts the American system should be used instead of the anna notation, i.e., 100 being taken to represent the normal crop and the estimated outturn being stated as a percentage of that crop, the conversion of the anna estimate to the percentage estimate being made either by district officers or by provincial authorities.

When these factors are determined, the *quantitative estimate of yield* is found by multiplying these factors. Thus if the area be 60,000 acres, the normal outturn per acre 500 lb. and the percentage estimate (seasonal factor) be 80, the total yield will work out as follows:—$60{,}000 \times 500 \times \frac{80}{100} = 24{,}000{,}000$ lb.

The defects of the present system.

There is no difficulty about the area figures. On the whole, these figures are sufficiently accurate and admitted to be better than the area statistics of other countries. There are, however, real difficulties with regard to the second and third factors.

Second factor. The figures of normal outturn per acre are mainly based on the results of crop-cutting experiments. These experiments have not yet been conducted on a large scale by trained officers of the Agricultural Department, as they should have been done, but by officers of the district staff having little or no expert knowledge of agricultural conditions and operations. Moreover, the amount of care and caution necessary for the experiments is not bestowed on them. Consequently the figures are only rough approximations to truth.

Third factor. The original "anna estimate" on which the seasonal factor is based is in most cases framed by the *patwari* (village accountant) or an officer of similar standing. These *patwaris* are not sufficiently intelligent, and, like most Indian cultivators, think too poorly of the crops owing to their ingrained pessimism. It is difficult for them to envisage what a normal crop is. The mental image of the normal crop which the *patwaris* have in mind when estimating crop condition is the crop which they would like to see but which they rarely see. They fail to realize that a normal crop over a great area must have its fair share of crop troubles. The result is that the normal in relation to which crop condition is estimated by the *patwaris* is something really above the normal. Consequently a normal crop is very rarely reported by them. Opinion is therefore unanimous that crop yields in India are greatly under-estimated.

It will thus be seen that it is desirable to improve the second and the third factors. The Board of Agriculture in their meeting held in 1919 considered the whole question and their conclusions are summarised in the following paragraphs.

The Board recognized that the area figures are hard to beat except in permanently settled tracts. They, therefore, could not suggest any method by which the area figures could be further improved upon except by the improvement of the detailed maintenance of land records in permanently settled tracts and by an improvement in the method of returning the area under "mixed" crops. As regards the area under mixed crops, the Board did not propose a definite method which would be better than the existing one. According to the existing method, each province has a set of rules framed for the purpose in conformity with the broad principles that the area to be returned must be the area covered by the forecast crop exclusive of the area covered by other crops with which it is mixed. The maintenance of detailed land records in permanently settled tracts will no doubt lead to an improvement in the area figures for these tracts: but the question is bound up with other considerations and is mostly a matter for the local authorities to decide.

With reference to the second and the third factors, the late Mr. G. A. D. Stuart, Director of Agriculture, Madras, proposed in 1919 a change in the procedure which was accepted by the Board. In the place of "normal or average yield" from crop experiments, which mean working from particular to general, he proposed the reverse process of working out particular from general. He suggested that a statement of "actual yield" of crops should be compiled at the end of each year by means of collection and detailed study of statistics of movement by rail and sea, of manufacture or of any process, such as baling, and of estimates of local consumption and carry-over. When this is done for a series of years (say, ten), the total of the actual yields divided by the total areas would give the "average yield per acre". As for the seasonal factor, Mr. Stuart would leave the *patawaris* to follow their traditional method of estimating in annas, but would interpret their estimates in the light of past experience and would translate them into intelligible language. Thus if the *patawaris* reported the following percentages of the normal crop in the past ten years 68, 79, 72, 85, 81, 74, 72, 83, 67 and 75 (total 756 or annual average 75·6), and report the crop of the year of report to be 83 per cent. of the normal, the seasonal condition of the year of report should be taken as $\frac{83\times100}{75\cdot6} = 110$ per cent. This means that assuming ten years to be a long enough period to eliminate seasonal fluctuations, the average or normal crop is that which the *patawaris* mark as 75·6 per cent. on his scale. Accordingly Mr. Stuart proposed the following formula for working out yields:

$$\text{Total yield} = \text{Area} \times \text{average of } \frac{\text{actual yield}}{\text{area}} \times \frac{\text{seasonal factor}}{\text{average seasonal factor}}.$$

Theoretically, Mr. Stuart's method seems to be an improvement, but the whole thing hinges upon the ascertainment of "actual yield". The determination of the actual yield of crops is attended with considerable difficulties; and this fact was recognized by the Board, although it was admitted that difficulties would not prove insuperable except in the case of sugarcane. In the first place, data of movements of crops have to be procured from the railway authorities. When the proposal was examined departmentally,

it was apparent that the statistics published by the railway authorities were not sufficiently detailed for the purpose and that their forms had to be altered in various ways before accurate information could be gleaned from them. Further there is an uncertain element, viz., local consumption, which has always to be guessed. Now with the recent abolition of rail and river-borne trade returns as a result of retrenchment, the determination of the actual yield of crops according to Mr. Stuart's method has become practically impossible.

It should be stated in this connection that the Indian Sugar Committee, which sat after the meeting of the Board of Agriculture, dealt with the question of compiling crop forecasts in India. The Committee, while endorsing the recommendations of the Board of Agriculture in general, held that, in the case of the sugarcane crop, the method of ascertaining actual yield is quite inapplicable as the proportion of the cane crop which is moved by rail is altogether negligible, the greater part of the *gur* manufactured being consumed locally, or moved by road. They also held that no satisfactory estimates of local consumption and carry-over, if any, could be framed. They were, therefore, of the opinion that so far as the sugarcane crop is concerned, the second factor, viz., the normal outturn per acre, must continue to be based on crop-cutting experiments, which, they recommended, should be conducted by the Agricultural Department in a regular and systematic way and on a larger scale than before by fixing the minimum number of the experiments to be made in the case of each province. As soon as figures on which sufficient reliance can be placed are available for a series of years, the method proposed by Mr. Stuart and accepted by the Board of Agriculture would be followed. This has been reiterated in the Meeting of the Board of Agriculture held at Bangalore in January last.

In the case of cotton, however, there is another method of calculating "actuals," viz., by means of press and mill returns. Cotton is first ginned in ginneries and then goes to pressing factories. But all cotton which is ginned is not pressed, some of it going direct to the mills. Again unpressed cotton not only goes direct to spinning mills, but is also used for extra-mill consumption, whilst

an appreciable amount of hand-ginned cotton does not pass through ordinary ginneries, but goes direct to press. Consequently the sum of the amount pressed in factories and the amount of unpressed cotton received in spinning mills gives the nearest approach to the actual crop. This method was tried and fortnightly returns under the name of "Cotton Press Return" were issued so far back as 1915 and continued till 1920, when they were abolished on the ground that they were hopelessly incomplete, there being no law compelling mill and press owners to furnish returns and much less accurate returns. There is, however, a proposal for reviving the weekly cotton press returns from all cotton-pressing factories which should be made compulsory as early as possible. In 1923 an Act called the "Indian Cotton Cess Act" was passed by the Government of India, Section 6 of which prescribed compulsory monthly returns of cotton consumed or brought under process in each mill. Unfortunately the Act extends to British India only. There are many cotton mills situated in Indian States, and consequently the returns of mill consumption expected to be obtained on account of the Act would serve no useful purpose unless Indian States prepare similar returns.

The examination of forecast figures, in the light of actuals when they are known, is helpful both to the mercantile community and to the officers entrusted with the preparation of crop forecasts. If the results are satisfactory, more reliance will be placed on the forecasts published and the responsibility of making correct estimates will be ensured. Such an examination is now made in the case of cotton crop only in the final general memorandum each year. Here the actual is taken to be the sum of net exports and consumption, both mill and extra-factory, the figures of mill consumption being furnished by the Bombay Millowners' Association and those of extra-factory consumption being conventional estimates made by the Cotton Contract Board (now the East India Cotton Association) of Bombay. In the present circumstances this sort of examination has not been possible for any other crop owing mainly to the absence of any reliable information regarding consumption.

With regard to the third factor, however, there is no difficulty in adopting Mr. Stuart's proposal for correcting the condition

estimate reported by the subordinate staff. A beginning has already been made in this direction and some of the provincial forecasts contain condition estimates as proposed by Mr. Stuart.

In crop forecasts comparison is generally made with the corresponding forecasts of the previous year. To meet the demand of the trade, comparison is sometimes also made with the final estimate of the previous year, although it may be somewhat misleading. For example, in India there are certain crops, such as cotton and sesamum, of which more than one variety is grown and the sowings of the late variety do not even commence at the time of the first forecast.

Non-official agencies such as large exporting firms, land-holders, trade experts, etc., are often in a position to render valuable assistance in arriving at correct estimates of outturn of crops and should be resorted to with a view to make the present crop estimates of greater value than at present. Some provincial Directors of Agriculture have realized the importance of this outside help and consult in some cases such non-official opinion, e.g., the Bihar Planters' Association in respect of the indigo crop. This system is, however, capable of greater expansion and more use than at present.

To sum up. On a consideration of the facts stated above it appears that all that is necessary and practicable in the present circumstances in regard to crop forecasts is—

(*a*) to leave the area estimates as they are,

(*b*) to pay more attention to the system of crop-cutting experiments in order to improve the standard normal outturns per acre, and

(*c*) to adopt Mr. Stuart's method of correcting the condition estimate reported by the primary reporting agency.

Method in foreign countries.

The methods followed in foreign countries, particularly in the United States of America and Egypt, may be of interest in this connection and are described below :—

U. S. A. According to the Department of Agriculture, Washington, for many years past, in fact since the Bureau of Census was

organized in 1862, it has been the practice to accept the estimates of acreage planted under different crops as reported by the Bureau of Census every ten years.* In the first year following the census, the crop reporters of this bureau would estimate the acreage planted as a percentage of the acreage reported by the census for the preceding year; the second year following the census the acreage would be estimated as a percentage of the acreage estimated in the preceding year, and so on, until figures for the next census are available. Theoretically, if there is no bias or tendency to under-estimate or over-estimate on the part of crop reporters, the acreage estimate by this method for the tenth year after a census would agree with the acreage reported by the census for that year. A weak point in the system which has long been recognized is the fact that individual crop reports are not free from bias, and there appears to be a fairly uniform tendency to either over-estimate or under-estimate the acreage, the result being a cumulative error which in ten years is apt to result in a wide discrepancy between the estimates of this bureau and the figures of the census. To illustrate, if the Bureau of Census should report 10,000,000 acres planted to a given crop, and there should be a uniform tendency on the part of the crop reporters of this bureau to under-estimate the acreage of this crop an average of two per cent. annually, this bureau might estimate the acreage as 9,800,000 acres in the first year after the census, as 9,604,000 acres in the second year, as 9,412,000 acres in the third year, and so on until the tenth year, when the bureau's estimate for the crop would be 8,170,000 acres. If during the ten-year period there had actually been no change in the acreage planted to the particular crop in question, and the census should again report an acreage of 10,000,000, the result would be a manifest discrepancy of 1,830,000 acres between the figures of this bureau and those of the census. Further discrepancies would appear in the yield per acre and the total yield.

* Prior to 1880, the census did not show acreage of crops, merely production; hence in the earlier years the acreage basis was obtained by dividing the census report of total production by an estimated yield per acre.

At or near the close of harvest each year agents and crop reporters of the bureau estimate the yield per acre, in bushels, pounds, or tons, according to the nature of the product. The estimate of the total production is readily obtained by multiplying the yield per acre thus obtained by the previous estimated total number of acres.

During the period of growth of crops, monthly forecasts are prepared to indicate as to how the harvests would finally turn out. The factors on which these forecasts are based involve, besides acreage, the condition of the crop at the time to which the forecast relates. The condition of a crop is expressed as a percentage of a normal crop usually denoted by 100. The idea of a normal crop is similar to that for India explained before. To make out forecasts, the condition figure is reduced to a yield per acre equivalent. This is done by means of what are called "pars" or the yield per acre represented by 100 per cent. At the beginning of each crop season, the statisticians of the crop reporting board of the bureau make a careful mathematical and statistical study of the relation of condition figures as reported each month with the finally determined yields in previous years. Having determined what a 100 per cent. condition, expressed in pounds or bushels per acre, has meant on the average for different months in previous years, a "par yield" for each month of the current year is established, which is used as a basis for converting "condition figure" into yield per acre equivalent for purposes of forecasting. The object is to fix a "par," which will, in the light of what has happened in previous years, most nearly fit the month for which it is to be used. The "pars," therefore, vary from month to month as the season advances in about the same proportion as the average "condition figures" vary. As harvest approaches, the forecasts approximate the final yields per acre much more closely than in the earlier months because of the fact that being nearer harvest, the crop is less subject to change in condition due to weather influences, soil fertility, insects, and diseases.

It will be observed that the method of estimating the yield per acre differs materially from the method of estimating the total

acreage, the acreage estimate being based upon a percentage of the preceding year's acreage, thus carrying on from year to year any error made in any previous year, whereas the yield-per-acre estimate, being based upon one year and not referring to any former year, is not affected by any error of a previous year. A constant yearly under-estimate of, say, two per cent. in the acreage will be magnified to a difference of about ten per cent. in five years and twenty per cent. (approximately) in ten years. A constant yearly under-estimate of two per cent. in the yield per acre will not be magnified in five or ten years. but, on the other hand, in comparing one year's estimated yield with another, the errors will be neutralized; that is, the effect would be the same, so far as comparative value is concerned, as though no error had occurred. In short, biassed errors in acreage estimates by percentages grow from year to year, biassed errors in yield-per-acre estimates neutralize each other.

The Bureau of Census enumerates total acres and total production of crops; if yield per acre is wanted, it is obtained by dividing the production by the acres. The Bureau of Crop Estimates obtains directly from its agents and correspondents estimates of acreage (as described) and yield per acre and arrives at the total production by multiplying acreage by yield per acre.

Notwithstanding the difference in methods of procedure, the estimates of yield per acre obtained by the Bureau of Crop Estimates in census years and the figures of yield per acre obtained by the census, with few exceptions, do not vary widely.

Egypt. The Director of Statistics, Cairo, describes the Egyptian method, in regard to the cotton crop, as follows:—The cotton crop is closely followed up by the provincial staff of the Ministry of Agriculture from the time of sowing until it has actually been picked and monthly bulletins are issued recording its progress. The inspectors, while availing themselves of the information supplied by the sub-inspectors, agricultural engineers and other members of the technical staff in the provinces, make extensive tours in the fields and visits to the villages to enable them to form their own opinion of the condition of the crop in its successive stages as a result of personal inspection and first-hand information.

On the 25th of each month, the inspectors supply the Statistical Service of the Ministry with notation figures indicating the condition of the crop in their respective provinces at the time of reporting. The notation figures are percentages of a normal (ten years' average) communicated to them before the crop is sown as representing a 100 per cent. yield. The notation figures once communicated to the Statistical Service serve to calculate the probable total yield for each province and, subsequently, the probable average yield per *feddan* (equivalent to 1·038 acres) for the whole country. The yields thus reckoned are liable to modification from month to month in reason of unforeseen factors influencing crop prospects.

The method of calculating the probable average yield is as follows: The area under cotton in each province (as supplied by the Direct Taxes Department of the Ministry of Finance) is multiplied by the normal (ten years' average) of the province and the resulting figure, being the total yield which should be obtained under ideal conditions, is again multiplied by the notation figure supplied by the inspector and divided by 100, and the product is divided by the area.

Towards the middle of October the inspectors are required to send in their forecasts of the crop in their provinces. The forecasts serve to check the final estimate of the crop made in November or December.

For the final estimate the system followed differs entirely from the one explained above and is known here as the "Square System". A "grid" is applied to the 1 : 50000 survey map sheets, and the villages within whose boundaries the points of intersection fall are taken as observation villages. There are about 300 such villages distributed all over the country. In each village twelve cotton-growing estates are selected, one having a total cultivated area of more than 50 acres, two between 20 and 50 acres, three from 10 to 20, and six from 5 to 10 acres. The members of the Inspectorate Staff keep in constant touch with the proprietors of these estates, and as soon as picking has been taken, accurate yield returns obtained from them are recorded on a special form and sent to the Inspectorate and thence to the Statistical Service

of the Ministry of Agriculture where they are checked and average yields for the various districts and provinces worked out on which the final estimate is made.

As regards returns from ginning factories a special form is sent out to all ginneries which they are asked to fill and return to the Ministry before November 5th, showing the average outturn of lint obtained from a *kantar* (99·05 lb.) of seed-cotton of the different varieties from the beginning of the ginning season up to that date. The ginners are not compelled by law to supply the information, yet no difficulty has so far been experienced in obtaining such information from them.

THE FUTURE OF COTTON-GROWING IN SIND UNDER PERENNIAL IRRIGATION.*

BY

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World production and demand.

One of the most live issues in the economic world to-day is the supply of raw cotton, and more particularly staple cotton. This issue is of peculiar importance to Britain owing to the great Lancashire industry of cotton spinning and weaving. The sources of supply of raw material to Lancashire have been gradually diminishing. Lancashire has for over a century depended mainly upon the United States of America for her raw cotton, and this source of supply is not only diminishing but actually threatens to dry up within a calculable period of time. This is due to two causes: (1) a diminished crop, and (2) an increased American mill consumption.

American production of raw cotton reached its maximum expansion in 1911-12 when the crop exceeded 16 million bales; since then the crop has steadily contracted owing to the depredations of the boll-weevil, and now it is anticipated that the crop will not again exceed 11 to 12 million bales.

At the beginning of the present century home consumption in the United States of America amounted to only 36 per cent. of the crop or 4 million bales. To-day it has reached 55 per cent. or $6\frac{1}{3}$ million bales.[1]

For the last 20 years the business men of Lancashire have realized that they must look to other fields for the supply of raw cotton, and strenuous efforts have been made to foster development

* Paper read at the Agricultural Section of the Indian Science Congress, Bangalore, 1924.

[1] *The British Cotton Growing Association Bulletin* 79, May 1923.

within the Empire. The most promising countries appear to be the Sudan, India and Nigeria. If for the moment we exclude India, we find that the total production within the Empire has not reached very large dimensions, and is not increasing very rapidly.

Thus the total crop in 1916 was estimated at 78,800 bales, while in 1922 the figure had grown to 103,400 bales. Apparently lack of communications is one of the chief obstacles in the way of rapid expansion in these Colonial areas. Lack of population, except in Nigeria, also appears to be a formidable difficulty.

Turning now to India, the crop has twice exceeded 6 million bales in recent years including 1921-22, but only some 1,400,000 bales[1] are of the quality required by Lancashire. After meeting the Indian home consumption demand, there are only some 200,000 bales of this quality available for export, of which the bulk goes to Japan.

It is thus evident that Lancashire has still much cause for anxiety with regard to her future supplies of raw cotton, and this fact would have been still more strongly realized had not the depression in the cotton goods trade masked the position by cutting down the demand for raw material.

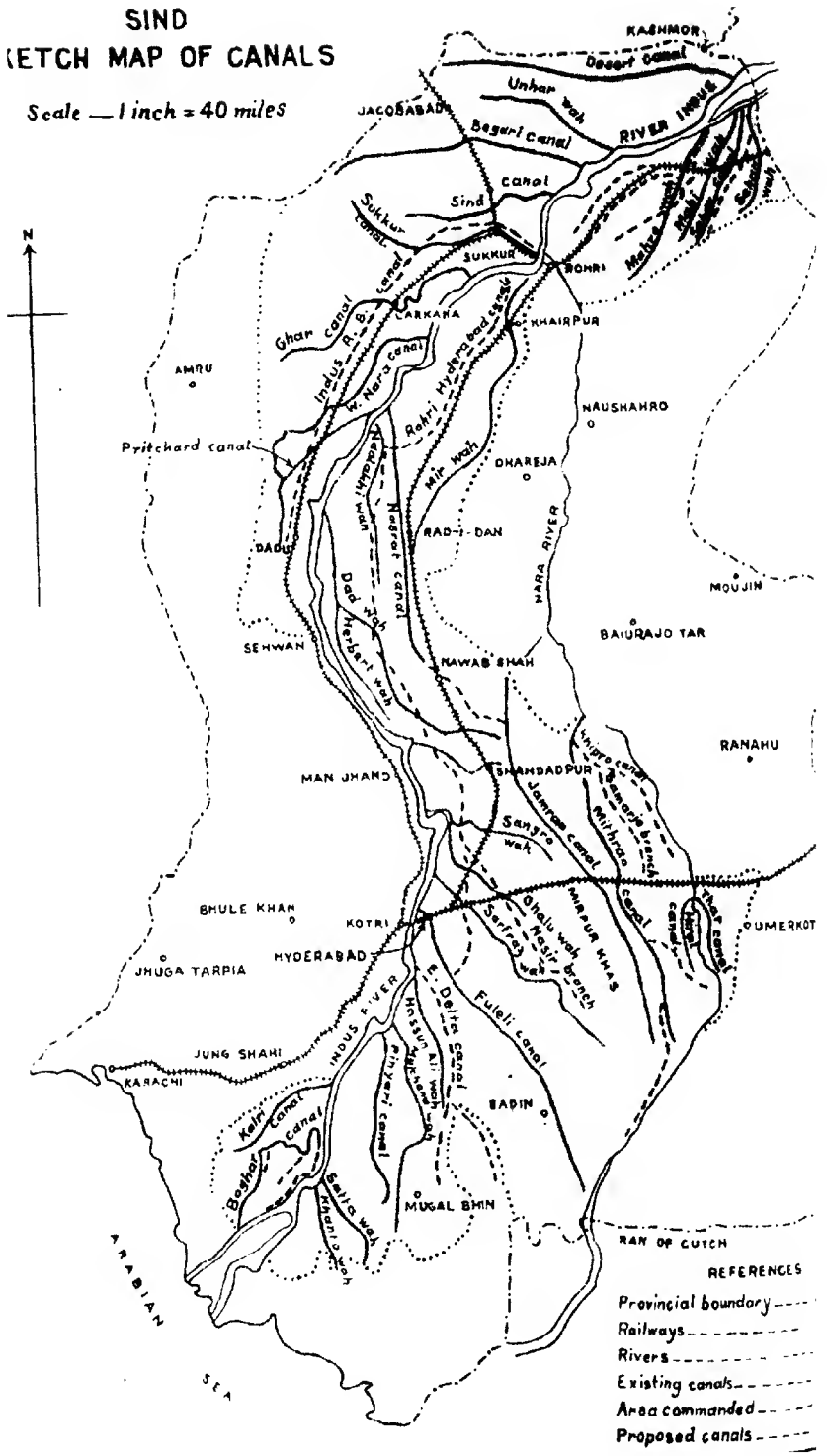
In these circumstances, one is forced to look to India to make a material contribution to the solution of this problem, and no part of India offers greater prospects than the irrigated regions of the North-West, including the Punjab and Sind. The Punjab already has 10 million acres of land under annual cultivation on her great canals, and large new schemes of irrigation are projected.

This part of India roughly coincides with the Indus plain. Rail-communications are good, and there is a large population already familiar with cotton-growing. The crop of this tract is easily brought to the port of Karachi.

Description of Sind.

Geographically, Sind is the most western part of India, and lies between 23° 35′ and 28° 29′ N. latitude, and is thus just outside the tropics.

[1] *The British Cotton Growing Association Bulletin* 81, July 1923.


SIND
KETCH MAP OF CANALS
Scale — 1 inch = 40 miles
N
KASHMOR
Desert canal
Unhar wah
RIVER INDUS
JACOBABAD
Begari canal
Sind canal
Sukkur canal
SUKKUR
ROHRI
LARKANA
KHAIRPUR
Ghar canal
Indus R. B. canal
W. Nara canal
Rohri Hyderabad canal
AMRU
NAUSHAHRO
Pritchard canal
DHAREJA
Mir wah
RAD-i-DAN
DADU
Nasrat canal
Dad wah
Herbert wah
NARA RIVER
MOUJIN
BAIURAJO TAR
SEHWAN
NAWAB SHAH
RANAHU
MAN JHAND
SHAHDADPUR
Jamrao canal
Sangro wah
Mithrao canal
BHULE KHAN
KOTRI
UMERKOT
HYDERABAD
JHUGA TARPIA
Ohalu wah branch
Nasir branch
Fuleli canal
JUNG SHAHI
KARACHI
INDUS RIVER
Kalri canal
Baghar canal
Phuleli canal
BADIN
MUGAL BHIN
Baria wah
RAN OF CUTCH
ARABIAN SEA
REFERENCES
Provincial boundary
Railways
Rivers
Existing canals
Area commanded
Proposed canals

The accompanying map (Plate XI) gives a general idea of the shape of the province, from which it will be seen that it consists of a longish strip of country with a river passing through the central portion. The length from north to south is about 350 miles and the width varies from 120 to 250 miles. The total area is about 30 million acres, comprised within 47,000 square miles. For the sake of comparison it may be interesting to point out that, in point of size, Sind is slightly less than England. Only about half of the province, or 15 million acres, is culturable, the other half being mainly mountainous and desert. The great feature of the province is the river Indus which drains a large section of the North-West of India. The discharge of this river at Sukkur at the height of the flood season has reached nearly a million cusecs, while in the cold weather, in March, the discharge has fallen below 20,000 cusecs. For all practical purposes, agriculture in Sind depends upon this river, as the rainfall is almost negligible (about 5½ inches). A series of canals withdraw water from the river and distribute it through the countryside. This water is heavily laden with silt and is highly prized for its fertilizing as well as its irrigating property. In the flood season, the banks are too low to contain the great volume of water, and hence there is a great overflow which formerly caused enormous damage, but the Indus River Commission, through the construction of protective bunds, roughly parallel to the banks, have succeeded in controlling these waters, and confining them within a strip of perhaps 10 miles in width. This overflow of silt-laden waters has created the interesting phenomenon of raising the river bed above the general level of the Sind plain, so that it actually flows along the crest of a ridge. The resulting slope is hardly discernible to the eye, but is sufficient to assist in the distribution and flow of canal water.

As the level of the water in the river varies through a height of 17 to 20 feet, when the volume of water is smallest and greatest, it is obvious that the supply to the canals will depend upon the river level. In practice the existing system of canals receives a supply for about four months from June to September inclusive. The river, however, is very uncertain—sometimes rising late,

sometimes subsiding prematurely, and frequently dropping during the course of the season. The agriculturist is never certain for how long or when he will be able to irrigate his crops. Another great disability is the liability of the canals to become choked with silt. Every cold weather a great amount of clearance work has to be carried out. This is due to the unsatisfactory design as regards lignment and slope and initial low level of the canals.

On the left bank of the river the greater part of the country is too high to obtain natural flow water from the canals, and hence an enormous amount of manual and cattle power is consumed in lifting water by Persian wheels. Sufficient has been said to illustrate how great are the economic disabilities under which agriculture is carried on in Sind, involving (1) insufficiency of water, (2) insecurity of supply, and (3) expenditure of energy on clearance of canals and lifting water. These factors have resulted in a very low standard of agricultural efficiency over a large part of the province. It is not worth while to sink much money or incur much effort on behalf of a crop which may never mature.

The same causes result in very poor use being made of the available land. The total annual cultivation in Sind is only 31 per cent. of the culturable commanded area, while a large area of culturable land is not commanded. Hence the annual cultivation is only some 3½ million acres out of a possible 15 million acres.

The obvious remedy of this state of affairs is to dam the river so as to maintain a high level of water, and to feed the canals from supply channels taken off from the river, just above the dam.

This idea has existed almost since the day when Sind became a part of British India, but the engineering and financial difficulties are very great, and have time and again baffled the attempts of those who have tried to design practicable schemes. Perhaps the greatest of the engineering difficulties has been the risk of causing a diversion of the river above the dam. A special feature of the Indus is its habit of changing its bed-site through wide distances. It seems, in fact, that a very slight obstruction, such as a deposit of silt, is sufficient to bring about material changes in the course of the river. Thus in the late forties of last century the idea of a dam

at Sukkur was considered and turned down by Lt.-Col. Walter Scott[1] of the "Canal and Forest Department;" since then there have been repeated attempts to project a feasible scheme, but they have all failed from one cause or another until the latest one.

The Lloyd barrage irrigation scheme.

This scheme embodies the collective judgment of many able men, and perhaps the two most interesting engineering features about it are the ingenious manner of eliminating the probability of causing a diversion of the river. These are: (1) The barrage is to be located not on a rock foundation as at one time considered essential, but on a sand foundation some three miles down stream from a rocky gorge through which the river has a considerable drop, and (2) the barrage is not to be constructed as a solid dam, but like a bridge, with a long series of arches. These will remain open during the flood season when the river is at its highest level, and the gates will only be closed when the river falls below the level required to feed the canals. This great scheme was only sanctioned in June 1923 when the Bombay Legislative Council finally accepted the scheme and found the necessary finance.

Two great non-silting canal systems will be fed from points immediately above the barrage. The right bank system contains three large canals and the left bank system four canals.

The amount of water to be withdrawn from the river is approximately 50,000 cusecs in the *kharif* season. Some idea of what this means may be gauged from the fact that one cusec is sufficient to irrigate an area of 70 acres of cotton or sorghum. This will be "flow" water, and it will cost the cultivator, in water tax, only some seven rupees per acre per season.

Some idea of the appearance of these canals, when completed, can be formed by comparison. Thus the largest of these canals will carry a normal volume of water equal to that of the Thames in heavy flood. Again the second largest canal, namely, the Rohri Canal,

[1] *Future of Sind*, by A. A. Musto, C.I.E.

designed to carry 10,250 cusecs, will be one and a half times as wide as the Suez Canal.

The following statement summarizes in round figures the areas affected by this great canal system, exclusive of some half million acres in Khairpur State.

	Area in millions of acres			
	Rohri Canal	Eastern Nara Canals	Right Bank Canals	Total
Gross commanded ..	3	2	2¼	7¼
Culturable commanded .	2½	2	2	6½
Proposed final annual cultivation	2	1½	1½	5½

Including Khairpur State, the gross commanded area of the whole project is just over 8 million acres, within which there will be some 6 million acres annually under crop. For comparison, it may be stated that the total area of Egypt is approximately 8½ million acres, while the total annual cultivation is 5½ million acres, so that this canal system alone will water half a million acres of crop over and above the entire crop of Egypt.

Here it must be pointed out that the Lloyd Barrage Canal System is essentially designed for grain production rather than cotton. Thus it is anticipated that there will be the following areas under different crops in British and Khairpur territory taken together: 8 lakhs of acres under rice; 17½ lakhs of acres under cotton, sorghum, etc.; 33½ lakhs of acres under wheat.

Cotton development.

It is anticipated that cotton will be found suitable for the whole of the commanded area, with the exception of the rice tracts, which amounts to some 50 lakhs of acres. But it should not be inferred that cotton will be grown on a half or a third of this area, as would be practicable if rotation were the only limiting factor. On the contrary the essential limiting factor to the possible cotton

area is the irrigation supply. The canals have been so designed as to ensure that they can be run at full supply level throughout the year; and as *rabi* (winter) crops require only half as much water as *kharif* (summer) crops, it follows that two-thirds of the cultivation must be conducted in the *rabi* season.

This arrangement was advocated by revenue officials with a view to securing the best financial results from the project.

The available water in the river in the *kharif* season is almost unlimited, being some 10 times greater than the 50,000 cusecs which this canal system is going to withdraw. Hence an alternative design would have been to construct much larger canals, so as to have permitted of a much larger *kharif* crop. This view was advocated by me in conference, but it was rejected on financial grounds and also because it would have meant running the canals much below their capacity in the *rabi* season. The latter objection does not seem to be a very convincing one, because the largest canal in the system is going to be run for six months only for rice, and closed for six months when the demand in the rice zone is expected to be nil.

The financial objection was a more formidable one because the entire cost would have to be debited to the *kharif* crop instead of, as under the present design, approximately one-third to the *kharif* crop and two-thirds to the *rabi* crop. The future will show whether the profits from cotton-growing will prove sufficiently insistent to enforce a reconstruction scheme to provide a larger *kharif* supply. The people of the tract affected prefer the *kharif* crop and liken it to the male sex in comparison to the *rabi* crop; and it is probable that they would be willing to pay a much higher sum than Rs. 7 per acre to irrigate cotton. Under the present design, the cotton area under full development may reach one million acres, though the area assumed in the estimates is about three-quarters of a million. As pointed out above, the area of culturable land believed to be suitable for cotton-growing within this irrigation scheme is some 50 lakhs of acres, so that there is ample room for a much larger cotton area, should the future demand for the product become sufficiently intense to justify a reconstruction scheme.

From the foregoing remarks it will be obvious that the facilities for growing cotton in Sind, after the new canal system comes into operation, are going to be entirely different from those which have characterized the past. In future there will be a huge area of land commanded by perennial "flow" irrigation, the supply of which will be regular and certain.

The improvement of cotton in Sind.

Efforts to improve the cotton of Sind have been carried on since the conquest in the forties of last century. This work may be conveniently divided over two periods. These coincide approximately with the second half of the nineteenth century and the first quarter of the twentieth. The former period covers the efforts made by the officers of the old Cotton Department, and the latter period the work of the Agricultural Department as constituted by Lord Curzon's Government. In the former period there was no perennial irrigation, while in the latter period there has been nominal perennial irrigation in the Jamrao Canal tract where the department has conducted its operations. In 1907, I published an article in the "Agricultural Journal of India" in which I described the attempts made in the first of these two periods to introduce a staple cotton into Sind. Representative varieties of cotton, as shown in the margin, were experimented with in various parts of the province, and these efforts were repeated at various intervals. The most sustained efforts were made in the seventies and eighties of last century.

Peruvian	Nankin
Egyptian	Sea Island
Bourbon	American
Hinghanghat	Broach
Dharwar	Baburich
Dharwar-American	Sind *desi*

These experiments all ended in failure, and looking back now, this failure must have been associated with the poor irrigation facilities, although it is interesting to note that the officers who did the work did not apparently take this view. As a matter of fact, the experiments were conducted at places where perennial water from pumps was available, and I can only surmise that full advantage was not taken of this facility. It seems probable that instead of sowing these exotic cottons early in March-April, as is

now recognized to be essential, the sowing was delayed till June, the normal time of cotton-sowing in Sind.

Mr. Strachan, who was connected with this work for 21 years, ascribes the failure to climate, and points out that just before maturity "the (Egyptian) bolls begin to shrivel and fall to the ground and the few capsules which do give cotton are seldom healthy". Mr. Strachan also pointed out that "the Egyptian variety seemed to suffer from very slight variation in the weather and eventually succumbed to the frosts of January". He also drew attention to the severity of boll-worm.

Mr. Strachan's remarks are quite intelligible to me, on the assumption that the crop was sown too late. In Sind, it is very desirable to secure the bulk of the crop by the end of November, as exotic cottons generally become unhealthy after this time unless the season has been very free from cold and dewfall.

As regards the second period, the Jamrao Canal was opened in 1900 and was designed as a perennial canal. Hence the departmental officers initiated their work with great hopes of success. At first, attention was concentrated upon Egyptian cotton, and a very favourable report was received from the British Cotton Growing Association upon the quality of the fibre. By this time an area of some 5,000 acres had been cultivated by the public, but unfortunately the canal soon proved to be unreliable, and hence Egyptian cotton had to be abandoned. At the same time, sufficient experience had been gained to show that the standard of cultivation would have to be improved, if this cotton were to be a success. Subsequently the department gave special attention to American cottons which also are exacting with regard to irrigation facilities, but less so than Egyptian.

A very representative collection of American varieties, numbering 30, had been got together by 1906. These were gradually narrowed down until 1912 when it was decided to concentrate upon Triumph. This variety did very well when sown early (April), but the canal could not be depended upon to permit of the sowing operations being conducted timely, and hence it fell out of favour with zemindars.

The Indian Cotton Committee in their report (published in 1919) went carefully into the efforts made to improve cotton in Sind, and summarized their conclusion with regard to the problem in the following words: "Provided a perennial supply of water can be assured, we hold the view that there is no other part of India which offers such hopeful prospects of the successful cultivation of long staple cotton. The climate and soil are, in every way, most suitable, and all that is wanted, is water at the right time and in sufficient quantity."

Here it may be useful to indicate the returns that can be got from cotton in Sind. I shall give some figures for Sind *desi* and 4F American, a very early type of American which has been able to secure a footing notwithstanding the unsatisfactory irrigation facilities.

Thus in 1922-23, a selected strain of *desi* (27 W. N.) sown on an area of 33 acres, on the Government Seed Farm at Mirpurkhas, gave an average yield of 954 lb. of seed-cotton per acre, including plots infected with *kallar* salts and subject to "wilt". The highest yield was 1,758 lb. of seed-cotton per acre. This cotton was ginned and the ginning percentage was 39 per cent., so that the average yield over 33 acres was just under a bale per acre. In certain villages in the Hyderabad District, yields up to 2 bales an acre have been reported. This cotton was sold for Rs. 44-8 per maund.* so that the gross return per acre amounted to Rs. 200.

Similarly in 1921-22 Punjab-American 4F was sown on an area of 30 acres and yielded 25 bales. The Cotton Contracts Board valued a saw-ginned sample of this cotton at Rs. 460 to 470 per *candy*, so that the gross return per acre was also approximately Rs. 200.

Both these cottons mature early. The *desi* crop begins to come on the market at the end of September. The Punjab 4F variety is very early. Thus in 1922-23 a crop sown in May gave 90 per cent. of its produce before the end of November.

From these figures it is clear that cotton has a bright future in Sind, and there is also evidence to justify the assumption that

* 1 maund = 82·28 lb.

good staple will be secured when the irrigation system becomes reliable under the new scheme. Thus in 1915-16 a bale of Triumph cotton was sent to Liverpool and the British Cotton Growing Association reported upon it as follows: "Very good colour, 'good Middling' in grade, staple $1\frac{1}{16}''$ to $1\frac{1}{8}''$, strong. Value 8·20*d*., with Middling American at 7·90*d*."

Again in 1916-17 the British Cotton Growing Association reported upon a sample of saw-ginned Triumph as follows: "This lot stands out and is a great advance on Indian cotton, clean, good colour, staple rough in character, $1\frac{1}{8}''$, some short fibre, strong, value 22·50*d*. Basis, Middling American 22·00*d*."

Any long staple cotton will have to be very prolific to compete with the two varieties just mentioned. In addition there are other limiting factors, notably, hardiness and earliness.

As regards hardiness, the future cotton of the province must be able to withstand the severe hot winds which blow in April and May. It must also tolerate a fair amount of *kallar* salts in the soil and prove resistant to red leaf-blight in the autumn months.

As regards earliness, all irrigation to cotton will be stopped in September-October, in order to provide for the huge area of wheat which is to be sown.

It is, therefore, evident that a long staple cotton will have to possess all these characters to compete successfully with existing cottons.

I think the department will be able to cope successfully with this problem, but the experimental work will have to be done with great care. For this purpose it is proposed to provide special facilities by the establishment of two stations equipped with perennial irrigation by pumping.

It is proposed to put a botanist in charge of cotton operations, and it will be his duty to explore all possible solutions of the problem of finding a high grade long staple cotton, suitable to the conditions of the province, as described above.

For the sake of completeness it will be necessary, once again, to test a large collection of exotic cottons under very rigorous

control. It is known from past experience that American cottons profoundly change their character when grown in Sind, but it is not known with certainty whether this is merely a reaction to the environment or due to cross-fertilization. For example, Triumph, a large-bolled variety, soon produces bolls of much smaller size, and the cause appears to be the dry atmosphere.

From my past experience I think the importance of securing hardiness, earliness and prolificness would justify the adoption of hybridization, using a cotton like 4F, which already possesses these characters, as the foundation parent. This cotton could be crossed with promising long staple exotic cottons with a view to securing staple in the resulting hybrids.

THE IMPROVEMENT OF THE COCONUT *JAGGERY* INDUSTRY ON THE WEST COAST.*

BY

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In a previous communication on this subject, published in the "Agricultural Journal of India" (Vol. XVII, Part IV), it was pointed out that the coconut *jaggery* (unrefined, raw sugar) industry on the West Coast afforded ample scope for improvement, and that, by the adoption of a simple sand filter and the use of alum for deliming the juice, it has been possible to obtain a better type of *jaggery* in point of cleanliness, colour and keeping quality than is to be found anywhere on the West Coast.

Analyses of a large number of samples show that *jaggery* prepared by us at the Kasaragod farm was by far superior to anything of the kind sold in the market. The table below gives typical analyses of the two kinds of *jaggeries*:—

Comparative analyses of coconut jaggeries.

	Country *jaggery*		Kasaragod *jaggery*	
	Sucrose %	Glucose %	Sucrose %	Glucose %
(Elmalai)	78·22	5·38	77·1	3·6
(Ponnani)	68·81	0·07	73·5	2·0
	75·36	4·00	83·5	3·2
	62·80	0·06	77·7	3·2
	61·18	11·37	77·8	3·8

* Paper read at the Agricultural Section of the Indian Science Congress, Bangalore, 1924.

Comparative analyses of coconut jaggeries—concld.

	Country *jaggery*		Kasaragod *jaggery*	
	Sucrose %	Glucose %	Sucrose %	Glucose %
(Podanur)	73·45	1·11	87·5	2·6
(Perur)	73·23	1·96	85·4	2·2
	73·58	2·18	83·3	5·2
(Kalmandapan)	71·57	2·24	86·5	4·2
(Perundurai)	71·29	0·83	85·4	4·2
	72·32	2·33	86·5	3·8
	69·58	4·15	85·4	6·6
			81·6	2·6
			80·3	3·6
			82·2	1·8
			81·0	2·2
			79·0	4·4
			80·6	3·6
			79·0	1·8
			81·9	3·0
			78·0	3·6
			81·0	3·4
			78·7	4·1
			80·3	3·2
			77·4	5·8

The improved kind of *jaggery* is well appreciated and commands a good demand. At the time our experiments were running, while the price of outside *jaggery* was 1½ annas a pound and easily available, the *jaggery* made on the Kasaragod farm was in great demand even at the enhanced rate of 2 annas a pound.

How the improved product is appreciated by the public may be seen from the following extract from an article in the "Madras Bulletin of Co-operation" (Vol. XIII, No. 8, p. 294) entitled "The Co-operative Manufacture of Palm *Jaggery*" by Mr. M. Shiva Rao of Puttur, South Kanara: "It may no doubt look as if an increased output of *jaggery* may not help to keep down prices at a reasonable level, since certain orthodox classes will never take to it however cheap it might be, and they would always be using cane *jaggery*. There is some force in this view but a change in the present method of manufacture of *jaggery* will, in all probability, take the citadel of orthodoxy by storm, and the sentiment against palm *jaggery* will be considerably weakened and disappear altogether in course of time. The fact has first to be published that what is called

'Palghat' *jaggery* and also the 'Ghati' *jaggery* coming from up-country and imported into this district is no more than palm *jaggery* prepared out of the sweet toddy of the 'Ichalu' (date palm). Secondly, palm *jaggery* should not be manufactured into flat thin round cakes as it is done now but made into cubicles of the same shape and size as the Palghat and Ghati variety. If it is thus put into the market, I believe, it will mend or end the existing sentiment against it. I do not put this forth as a mere theory but as a certain consequence, since it has been experimentally tried and found to succeed. Through the kindness of the Kasaragod Co-operative Inspector in South Kanara I had recently got samples of *jaggery* prepared out of coconut sweet toddy in the Government Coconut Station at Kasaragod, and some of my orthodox Brahmin friends gladly took samples from me after tasting them in my presence. They were immensely pleased that such fine *jaggery* could be made in our district and they seemed almost anxious to start the industry themselves on a sufficiently big scale."

This paper deals with some of the difficulties which are likely to occur in the collecting of *juice* and making of *jaggery* and experiments on the production of brown sugar from coconut sweet juice. It will be some time before a full detailed report on the subject of coconut sugar production, from the tapping of the juice to the marketing of the finished product, will be available. It is, therefore, considered desirable that the results of further experiments on *jaggery* and brown sugar production should be published as a second notice.

The making of *jaggery* by the improved alum method on the Kasaragod farm was continued for the major portion of the year 1922, and invariably hard light-coloured *jaggery* was obtained. Suddenly, about the end of March of the same year, it was found that when the juice was concentrated as usual it would not set to *jaggery* either by the improved alum method or the usual village method. All sorts of modifications in the technique of boiling were tried to no avail. The juice as brought down from the tree was tested for any fermentation, but no signs of it could be discovered. Eventually the trouble was traced to the improper

cleaning of the pots. Experiments 1–3 detailed in the Appendix clearly show that the trouble arose on account of imperfect cleaning of the pots in which juice was collected. It appears to us that as a consequence of inefficient cleaning of the pots incipient fermentation set in, with the result that the usual setting of *jaggery* was seriously interfered with.

Our experiments distinctly show that proper washing and liming of the pots and putting them mouth downwards when not in use is ordinarily enough; but where for any cause this is found insufficient, rinsing the pots with water in which a small quantity of copper sulphate is dissolved, and subsequent washing and application of good lime will improve matters. This method of cleaning can be easily adopted by the tapper as the amount of copper sulphate required is so small that it would not cost him more than a quarter to half an anna, and this quantity can be used for a number of pots successively. If after use this is stored in a small pot the same copper sulphate can be used a number of times.

Brown sugar.

The idea of preparing brown sugar direct from the coconut juice appeared feasible in view of the fact that *jaggery* prepared from unfermented juice was markedly crystalline in structure, and showed very little glucose on analysis. A small centrifugal butter drier was kindly placed at our disposal by the Superintendent, Central Farm. Fitted with a cylinder of brass wire netting with very small meshes, this proved quite suitable for our experiments. To prepare the sugar, boiling was stopped a little short of the *jaggery* moulding stage, and the syrup left to cool and crystallize in a shallow vessel. The time taken for complete crystallization and the size of the crystals depended of course on the concentration at which the syrup was removed off the furnace. With a little experience one could easily judge the stage at which the maximum amount of crystallization would take place. Percentage of sugar obtained this way ranged from 7·5 to 9 on the weight of juice or 55 to 65 on the weight of *jaggery*. Details of a few typical experiments are given in the Appendix. Nothing like thoroughness

is claimed for these trials which were only slightly larger than laboratory scale experiments. Our object in describing them is merely to show that a good crystalline sugar of fair purity could be easily obtained from the juice of the coconut. One reason why it is worth while to prepare brown sugar, at least in the rainy season, in the place of *jaggery* is that the sugar has much better keeping qualities than the *jaggery*. It sold at 3 annas a pound when *jaggery* was selling at half the rate, so that taking the yield at 50 per cent. on the *jaggery*, there would be no loss at all. If the molasses could be utilized, it would even be a distinct source of profit.

Economics of the Industry.

In view of the proposed publication of a detailed report on the subject in all its aspects, we do not propose to deal at length with the economics of the industry. But, as our object is to stimulate *jaggery* production, we wish to emphasize the fact that *jaggery* making is more profitable than either selling the juice as toddy or leaving the tree to bear nuts. As the coconut juice is drawn from the inflorescence, the use of a tree for *jaggery* manufacture would mean the entire stoppage of the supply of nuts and the consequent loss of revenue under that head. The juice itself may either be boiled into *jaggery* or collected without any preservative and sold as fermented toddy. For the latter the tapper has to obtain a license on payment of Rs. 7-8 a tree per year. When working out the economics of the *jaggery* industry, therefore, a comparison has to be made between these three sources of income from the tree. The average daily yield of juice from a fairly good tree may be taken at two bottles or roughly $3\frac{1}{2}$ lb. This quantity would boil down to $\frac{1}{2}$ pound of *jaggery* fetching 9 pies a day or Rs. 17 a year. Of this, a sum of about Rs. 2 has to be paid to the owner of the tree. Deducting Rs. 4-8 for fuel purchased—granting that fuel has to be purchased throughout the year, and that the expenditure under this head would amount to about a fourth of the sale proceeds of *jaggery*—the net profit would be Rs. 10 a year from a tree. If, on the other hand, fermented juice is drawn and sold to the shop renter at the usual rate of 4 pies

a bottle, the income under this head would amount to Rs. 15 a year. After payment of Rs. 7-8 as tax and Rs. 2-8 to the owner, the tapper gets only a profit of Rs. 5. Now such a tree may be supposed to yield about a hundred nuts a year. At the normal rate of Rs. 50 a thousand, the amount realized by the sale of nuts would come to Rs. 5 only. The amount due to the owner may be considered balanced by the saving on tapping accessories, etc. Of the three, therefore, the tapper finds *jaggery*-making the most profitable, besides being a source of daily income to him.

In conclusion, our thanks are due to the Deputy Director of Agriculture, VII Circle, and the farm staff at Kasaragod for facilities afforded for our work.

APPENDIX.

Experiment 1. 14 pots were well washed, smoked, rinsed with dilute copper sulphate solution, and washed again with boiling water. 20 c.c. of formalin were put in each of four of these and the remaining ten were limed. All were then kept on spathes that yielded well. The contents of the formalined and limed pots were collected separately the next morning and analysed with the following results :—

Formalin		Lime	
Brix	Sucrose %	Brix	Sucrose %
16·64	14·40	16·33	13·34

Liming was normal, juice clear and distinctly alkaline.

The juice collected with formalin was made just alkaline with KOH, and the limed juice simply filtered clear. The two were boiled down separately. *Jaggery* from formalined juice was very hard and light-coloured and kept colour; that from the limed juice set well and kept colour, though it was not as hard as the other. *Jaggery* from the usual boiling set also, but was not as hard as either of these.

Experiment 2. Pots were subjected to the same treatment as above. Trees selected for formalined and limed juices were the same as before. Analysis of juice showed :—

Formalin		Lime	
Brix	Sucrose %	Brix	Sucrose %
16·48	14·65	16·14	13·12

Liming slightly above normal. Formalined juice was strained through cloth only, while the limed one was filtered through sand. The former gave the same hard, good-coloured *jaggery* as on the previous day, but the *jaggery* from the limed juice was soft and darkened soon. The product of the usual boiling did not set.

Experiment 3. Pots treated as above, but all were limed only. Juice from the four spathes from which formalined juice was drawn on the previous days was collected separately. Analysis :—

Limed (Four pots used for formalin previously)		Limed (The ten remaining pots)	
Brix	Sucrose %	Brix	Sucrose %
16·44	13·85	16·68	13·98

Liming slightly above normal. Juice from all the pots was mixed and strained through sand. Half was boiled down straight away and the other half treated with alum, allowed to settle, decanted and boiled. The untreated juice gave the usual soft *jaggery*, whereas the one treated with alum gave a very hard, light-coloured product.

Brown sugar.

Experiment 4. Amount of juice available for boiling was 134 lb. When concentrated sufficiently (temperature 116° C.), it was allowed to crystallize in shallow pans and centrifuged after eight days. Crystals were large and well defined.

Yield : 10 lb. brown sugar and 14 lb. molasses.

Yield of brown sugar = 7·5 per cent. on juice or 53·2 per cent. on *jaggery*.

Experiment 5. Weight of juice 120 lb. Juice arrived at the shed by about 11-30 a.m. Preliminary sand filtration was over by about 12 noon. Alum was added and the juice boiled, and allowed to settle for 2 hours. Sample taken just before leaving to settle showed : Brix 17·34, sucrose 13·24, glucose 0·91.

After 2 hours the juice was decanted. It was clean and bright. Just before beginning to boil at 4 p.m. another bulk sample was drawn and analysed to see if any inversion or fermentation occurred. Analysis : Brix 17·47, sucrose 13·40, glucose 0·91. The syrup was taken out to crystallize at a slightly later stage than before and while hot a spoonful of white sugar was stirred in. Crystallization was complete by next morning. Centrifuged at once. Crystals were finer and better coloured than on the previous day.

Yield : 11 lb. sugar and 9½ lb. molasses. Percentage of sugar on juice = 9·17 ; on *jaggery* = 65·5 (assuming the yield of *jaggery* to be 14 per cent. on weight of juice).

Crystals being very fine, the molasses contained a good deal of sugar that passed through. It was, therefore, slightly further concentrated and left over. No crystallization occurred on the next day. A few crystals of white sugar were stirred in. No further crystallization was observed even after four or five days.

Experiment 6. Weight of juice collected was 149 lb. Juice arrived at 12 noon and was filtered and alummed by 1 p.m. and allowed to settle till 3 p.m. It was then boiled down till temperature showed 116° C. Juice analysed before settling showed : Brix 16·51, sucrose 13·34, glucose 0·77. Clear juice drawn off at 3 p.m. before concentration gave : Brix 17·69, sucrose 13·35, glucose 0·83.

By next morning a plentiful crop of crystals appeared. Syrup was centrifuged after 3 days.

Yield : 11½ lb. sugar and 12 lb. molasses.

Percentage of sugar : 7·7 on juice or 54·8 on *jaggery*.

Analysis of a sample of molasses showed 50 per cent. of sucrose. With more efficient arrangements for the separation of crystals, the amount of sucrose could probably have been kept dow n further still.

SELECTED COIMBATORE CANES IN GROWERS' FIELDS IN NORTH BIHAR.

BY

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Secretary, Sugar Bureau.

It has been mentioned in a previous article by the present writer on "Mill Trials of Selected Coimbatore Seedling Canes" published in the "Agricultural Journal of India" (Vol. XVIII, Part III), that, as the result of thorough testing at Pusa, three seedlings, viz., Co 210, Co 213 and Co 214, were found to be superior to the canes grown in North Bihar, not only as regards tonnage and improved sucrose content but also in their practical freedom from disease when grown as field crops. It was also reported in that article that, as soon as the mill trials were found satisfactory, a large demand for these canes came in from the growers in Bihar, but as the supply of seed-cane was very limited, only the available quantity of these three varieties was distributed in February 1923. In distributing these canes care was taken to select growers from as many districts in the White Sugar Tract as possible, viz., Monghyr, Darbhanga, Muzaffarpur, Champaran, Saran and Gorakhpur, with a view to find out how these three canes behave under different soil and cultural conditions. As most of the growers had not at the time got the implements for planting recommended by the Sugar Bureau, it was considered worth observing whether, with the methods likely to be adopted at the time by the growers, these canes would still show their superiority over local canes. It may be mentioned that at Pusa, where the soil is not considered to be first class soil for cane-growing, the yields of the three varieties, Co 210, Co 213 and Co 214, in years of normal rainfall have averaged 700, 800

and 600 maunds* (i.e., roughly speaking 25 tons, 29 tons and 22 tons), respectively, of stripped cane per acre, as compared with the 300 maunds (about 11 tons) of *Hemja* or *Bhurli* locally grown.

A circular letter was issued by the Secretary, Sugar Bureau, to the various growers requesting them to report their experience with these canes. Their replies show that almost all were pleased with the results they got. The germination of these canes was excellent, being much earlier and more vigorous than that of the local canes, they started to make a much more vigorous growth and they also stood the hot weather very well. The results would have been much better as regards the final yield if, as the growers say, the monsoon had been normal. As a matter of fact, the whole of North Bihar had in the year 1923 the most deficient rainfall for very many years. It is, however, a matter for satisfaction that even under such adverse conditions the growers were convinced of the superiority shown by these selected Coimbatore seedlings on their own fields planted and grown by their own staff under their own conditions. A valuable asset has thus been created in a body of large growers who have seen for themselves that what is recommended to them by the Sugar Bureau is not only capable of being reproduced on their own fields but of even being improved upon. They are now taking up the improved planting outfit recommended by us and have begun to see the value of improved cultivation and manuring. These are very hopeful signs, and we expect to see solid progress in this direction in the near future.

We will now quote relevant extracts from the letters of some growers as regards the cultural methods adopted and the yields obtained by them.

Mr. Dalrymple Hay of Jeetwarpore near Samastipur (Darbhanga District) gives the yields obtained by him as follows :—

Co 214 .. 560 maunds per bigha, over 24 tons per acre.
Co 213 .. 400 „ „ „ „ 17 „ „ „
Co 210 .. 740 „ „ „ „ 32 „ „ „

* 1 maund = 82·28 lb.

He reports that all these varieties were planted in the same quality soil and were given farmyard manure. The low yield of Co 213 was, in his opinion, due to the effect of trees at a short distance on part of the land. The rainfall was only 32·60 inches with no heavy downpour, and moisture was poor. He concludes as follows: "All these canes are much better than *Bhurli* (local cane) which with same treatment is only cutting out at best 300 maunds."

Mr. G. P. Danby of Bowarrah, District Muzaffarpur, writes to say that *he got 30 tons per acre on an average*. He grew these canes both on light and heavy soil. The land was given a little farmyard manure and in some mustard oil-cake at the rate of half a ton per acre. The rainfall was only 24 inches. He concludes his letter with the following observations: "All the canes did very well but Co 213 and Co 210 cut out the best, although Co 214 proved itself to be a hardy and healthy cane. All stood the drought exceedingly well."

Mr. C. Atkins, Manager, Dowlatpur Agricultural Concern, District Darbhanga, writes that he grew these canes on light sandy soil. The rainfall during the monsoon period was only 18 inches as against the normal of 49. The crop yield obtained was:—

Co 214 .. 300 maunds per acre.
Co 210 .. 375 .. .. ..
Co 213 .. 593 .. .. ,,

The following is an extract from the letter dated the 1st March, 1924, of Mr. J. Hemish Walker, Cane Superintendent, Ryam Sugar Factory, District Darbhanga:—

"*Tonnage per acre of Coimbatore canes cut.*

"(1) Co 214 .. 21·4 tons per acre.
Co 213 .. 29·0 .. .. ..
Co 210 .. 19·3 .. .. ..

"(2) Co 214 in sandy soil with patches slightly 'Oosur' (alkaline).
Co 213 average soil slightly heavier than 214.
Co 210 - fairly stiff soil, with a good deal of clay.

"Manure in all cases 190 lb. sulphate of ammonia per acre. No other manure given and land was in poor condition until a month before planting, which was done in October-November 1922. Crop was kept entirely free from weeds, and when cut, land was clean.

"(3) Condition of crop was good.

"(4) Rainfall for year was 38·33 inches of which 4·50 inches fell on 3rd and 6th October. A regular weekly analysis has been made of each variety from 17th November up to 26th February, and will be continued in the case of Co 213 and Co 214. A complete stool is used in each case, every cane being ground, and an average sample taken for analysis. Results show that canes have improved in quality up-to-date and show no sign of falling off."

Mr. E. J. Finch of Manjhaul Factory, District Monghyr, reports as follows:—

"I have not weighed out my Coimbatore canes as most of what I had has been used for seed purposes; however, I sent a little of my Co 214 that I did not require to the Samastipur Mill, and it worked out at maunds 376 per acre. The *Bhurli* alongside is only giving maunds 300.

"The soil I had these canes in is a sandy one.

"The condition of the crop, considering the year, was quite good. The crop had maunds 15 per bigha of *mahwa*-cake (*Bassia latifolia*) applied at time of planting.

"My rainfall was 21 inches, i.e., from the 1st June to 31st October, against my 20-year average of 47 inches."

Mr. H. K. Gray of Mia Chapra, District Muzaffarpur, grew these canes on a rainfall of 22 inches. He grew Co 214 in fairly good land and manured it with farmyard manure and got a crop yield of 520 maunds per acre. *His Co 214 was sown in good land manured with castor-cake at the rate of 50 maunds per acre and the result was an outturn of 1,140 maunds cane per acre.* He says: "The results would have been much more favourable, had the rainfall been normal."

Mr. E. C. Crane, Manager, Pernekpore, District Muzaffarpur, reports that he got 500 maunds per bigha (i.e., 600 maunds per acre) from Co 214 and that the condition of the crop was good.

COIMBATORE CANE 213 ON HEAVY LAND AT PUSA IN 1923 (RAINFALL 24 INCHES).

Mr. S. N. Bose, Manager, Kanti Concern, District Muzaffarpur, reported the condition of the crop good, considering last year's poor rainfall. He was unable to give the tonnage of the canes separately but he said he would be able to plant over 30 acres with these canes.

The Manager, Turcouleah Concern, District Champaran, got approximately 700 maunds cane per acre from Co 213. He applied 20 maunds of castor-cake per acre and regularly irrigated the crop before the break of the monsoon. The rainfall on his estate was only 24 inches.

To summarize. It is clear from these extracts that in spite of the unfavourable monsoon these three Coimbatore seedlings have shown their superiority under similar conditions over the local cane in the growers' own fields. Of these three canes, while each has got its own good points, Co 213 is liked best by the growers and also by the sugar factories as a general utility cane. It is easily the first in tonnage, second in sugar, lowest in fibre but with enough fibre to make it a good all-round factory cane. Consequently there has been a heavy demand for the seed-cane of this variety and 19,000 maunds have been distributed this season. Of the other two varieties. 11,000 maunds of Co 210 and some 6,000 maunds of Co 214 have been distributed this February, and it can be said that these canes are now well established in North Bihar. It is most unfortunate that the canes had to be planted this season in a soil with very little moisture, and as cane is not usually irrigated in Bihar even during the hot weather months, these varieties will this year be put to the severest test any cane has to undergo. The results, therefore, of this year's growing will be awaited with considerable interest if not with anxiety, as both the growers and the factory industry believe that with the establishment of these canes in the district the sugar industry in Bihar will rest on a sound basis.

It may here be mentioned that by far the majority of cane-growing countries ratoon canes owing in most cases to scarcity of labour and its consequent cost. In parts of India like Assam and

Burma where there is a shortage of labour it is essential that the cane grown should be a good ratooner in order to enable the grower to keep his maximum acreage under cane. In the White Sugar Tract of North India with its dense population and cheap labour it may not be so necessary to keep ratoons, particularly because ratoon cane is far more liable to harbour disease if once it gets introduced in the districts. But considering the fact that labour is an ever rising market, it is none the less desirable to study the ratooning qualities of the canes which are being recommended for adoption by growers. Accordingly, experiments in connection with the ratooning qualities of Co 214, Co 213 and Co 210 were carried out at Pusa during the year. Here again the exceptional deficiency in the rainfall hampered the obtaining of data applicable to a normal year. It was, however, seen that under such conditions Co 214 and Co 210 can be successfully ratooned. Co 213 with its larger leaves and greater transpiration surface undoubtedly requires more moisture than was forthcoming, and while the other two canes made good progress, the growth of Co 213 was badly checked with the result that about 6 acres of this cane failed to fill and a large proportion of the cane hollowed out, rendering it unfit for seed or crushing. This cane was on light land, and it is probable, though not definitely proved, that to obtain the best results from such a heavy tonnage cane a minimum rainfall of 40 inches is essential and the cane should go on stronger land than the other two varieties. Co 210 and Co 214 with their smaller leaf area showed no signs of checking, and the hollowing out referred to above did not appear in these varieties. The incidence of fungus disease was almost nil, but considerable leaf dryage was in evidence towards the end of January, which however did not affect the cane. The yield averaged some 400 maunds of unstripped cane per acre for both Co 214 and 210, while Co 213 failed completely.

Further ratooning experiments are being carried out this year with a view to find out whether under normal rainfall these three varieties give higher yields than those recorded above. Questions such as the treatment of the stools and general manuring will also receive attention, as it is necessary to ascertain the profits

derivable from ratooning these canes as compared with those obtained from plant cane.

Note. Since the above was written, reports have been received from the growers stating that these Coimbatore seedlings, though planted on deficient soil moisture, successfully withstood the hot weather which was exceptionally severe this year and are now far ahead of the local canes. As the monsoon has so far been favourable in this tract, the growers expect a good crop of these seedling canes. [W. S.]

THE VALUE OF GREEN GRAZING FOR WORKING CATTLE.

BY

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AND

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WORKING cattle in Western India are not usually supplied with green grazing or with green feed in the stall. Their usual food consists of *kadbi* (sorghum straw) supplemented by concentrated feeds as found necessary. It is nevertheless generally recognized that animals which are able to obtain grazing facilities on good green grass, or which are fed with succulent green fodders in the stall, require a good deal less concentrated food than is given under the more usual conditions; and when such sources are available the owner does, as a matter of fact, usually curtail the concentrates to an appreciable extent, some even going to the length of not supplying any at all under such conditions. In South Gujarat, during the monsoon months, when grazing is available, the work cattle are generally fed with fresh *til* (sesamum) cake at the rate of only one to two pounds per head per day even when the animals are on heavy work such as tillage. In North Gujarat, *guar* seed (*Cyamopsis psoralioides*) or cotton seed usually takes the place of the *til* cake. Kelkar states that, with good grazing, one pound of oil-cake and a little salt will suffice for dry animals, while in the case of milk animals one-third of the normal full ration is ample to meet all requirements. No exact experiments, so far as we are aware, have, however, been made to determine the extent to

which good grazing will replace concentrated feeds for working cattle. The record of such experiments for a part of two seasons at the Chharodi Farm may, therefore, have considerable interest.

Details of the experiments.

Ten bullocks were each year selected for the experiment and arranged in convenient pairs. They were weighed daily in the morning before watering, and regular work was given daily. The work consisted usually of cart haulage on the farm, with a little variation here and there. The concentrated food supplied throughout was wheat bran, and during each period of the experiment a definite amount of this fodder was given. The amounts given varied from one pound to three pounds of bran per day. Good green grazing was available throughout, and when the animals could not be allowed out, green grass was supplied in the stall, as much as the animals would eat. Rock salt was freely given. Each period of the experiment lasted eight or more days.

The test cattle were worked daily for a few days before test, and were fed with green grass only. After the termination of the whole experiment they were again worked daily without any other food except green grass.

The mixture of grasses and other fodder plants in the area being grazed by the animals was roughly as follows:—

	Per cent.
Iseilema Wightii	15
Andropogon annulatus	20
Andropogon forcoletus	3
Andropogon pumilus	2
Chloris pallida	10
Aristida abscensis	5
Ischæmum rugosum	15
Politoca barbata	17
Apluda varia	3
Indigofera cordifolia	10

The experiment was divided into two parts: In the first bullocks weighing 1,000–1,150 lb. are dealt with; in the second animals from 850 to 900 lb. in weight were employed.

RESULTS OF THE EXPERIMENTS.

Heavy bullocks. The following table shows the weights of the animals after each stage of the experiment, during each of the two seasons of 1922 and 1923, with 1 lb., 1½ lb., 2 lb., 2½ lb., 3 lb., of bran respectively, and also the original weight and the final weight when working without bran. The bullocks marked A and B in each case were working together as a pair.

Number of bullock	Before experiment	Average weights					After experiment
		With 1 lb. bran	With 1½ lb bran	With 2 lb. bran	With 2½ lb. bran	With 3 lb. bran	
1922							
	lb.	lb.	lb.	lb.	lb.	lb.	lb.
I A	1,139	1,137	1,126	1,129	1,131	1,126	1,118
I B	1,141	1,144	1,147	1,118	1,153	1,138	1,149
II A	1,017	1,002	1,006	1,026	1,027	1,036	1,034
II B	1,064	1,056	1,050	1,039	1,052	1,064	1,055
III A	1,043	1,043	1,023	1,029	1,036	1,037	1,041
III B	1,078	1,086	1,071	1,067	1,071	1,082	1,094
AVERAGE ..	1,080	1,078	1,070	1,068	1,078	1,080	1,082
1923							
I A	1,152	1,161	1,165	1,144	..	..	1,157
I B	1,250	1,261	1,261	1,245	..	..	1,239
II A	1,029	1,039	1,030	1,026	..	..	1,029
II B	1,045	1,046	1,044	1,049	..	..	1,035
III A	1,095	1,114	1,117	1,131	..	..	1,087
III B	1,061	1,070	1,066	1,046	..	..	1,053
AVERAGE ..	1,105	1,115	1,114	1,106	..	..	1,100

The bullocks were the same in the two years except in the case of II B, which was a new one.

The general result in this case is clear. Discarding individual variations, it would appear that with moderate farm or carting work the weight of animals can be well maintained by good green grazing alone, provided the animals can get all they wish to take, and that the addition of bran is of no advantage.

Medium bullocks. The following table shows the weights of smaller animals after each stage of the experiment during each of the two seasons of 1922 and 1923. The details are similar to those in the experiment last recorded.

Number of bullock	Before experiment	Average weights: With 1 lb. bran	With 1½ lb. bran	With 2 lb. bran	With 2½ lb. bran	With 3 lb. bran	After experiment
	lb.	lb.	lb.	lb.	lb.	lb.	lb.
1922							
IV A	901	924	920	924	935	931	910
IV B	845	860	870	875	892	896	868
V A	859	842	854	868	876	861	847
V B	920	924	932	945	940	928	946
Average ..	881	887	894	903	911	904	893
1923							
IV A	947	953	955	957	..	..	946
IV B	978	988	987	991	..	..	974
V A	898	897	900	906	..	..	890
V B	883	881	892	888	..	..	867
Average ..	926	930	933	935	..	..	919

In this case the bullocks were not the same in the two years, except in the case of No. IV A.

The general result is again evident and the results are as consistent as can be expected with such variable material as animals of this class. Not only have the bullocks maintained their weight, when given moderate farm or carting work, on green grass alone, but the addition of bran has given always an increase in weight when accompanied by sufficient grazing.

We commend these results to the holders of working animals. During the season when green grass is abundant, concentrated foods would seem to be unnecessary for bullocks employed on ordinary farm or moderate carting work, provided the animals have as much green fodder as they wish to take and time to get it. Similar experiments in other parts of India would appear to be needed.

LANTANA FLIES (*AGROMYZA LANTANAE*, FROGG.) IN HAWAII.

BY

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THE question of the introduction of the Lantana-seed-fly into India as a means of checking the spread of this noxious weed has been engaging the attention of several of the Provincial Governments in India, and the writer has received so many requests for information regarding the observations of the fly that he made in the course of his stay at Honolulu that an account will probably prove of general interest. Dr. Coleman, the Director of Agriculture in Mysore, was the first to try the introduction of the fly in India. As early as 1913 on his way back from deputation abroad he had visited Hawaii and was shown round a few places in Honolulu where Lantana was believed to have been checked appreciably by the insect. On his return he lost no time in arranging for a consignment with Mr. O. H. Sweezey, Entomologist of the Hawaiian Sugar Planters' Association, to whom this department owes much for assistance rendered then and subsequently. Unfortunately, however, there was no through service of steamers from Honolulu at that time and sufficient care was not taken of the parcel during the transhipment so that the parcel arrived with all the flies emerged and dead. No further attempt was made as it was felt that the experience was likely to be repeated. Moreover, some of the Provincial Governments had become interested in the question of introduction and when the matter was referred to Mr. Bainbrigge Fletcher, the Imperial Entomologist, he had suggested an investigation of the insects already in India, and it was felt that nothing should be done before this investigation was completed.

Rao Saheb Ramachandra Rao of the Madras Department of Agriculture was deputed to the work, and in the elaborate and interesting report[1] he published in 1920 he recommended the introduction of the fly—a conclusion, however, opposed by Mr. Fletcher in his introductory note to the Memoir. Mr. Fletcher's main reason was the apprehension that the fly may attack other plants of the Verbenacious group, especially teak seeds. This possibility had occurred to Rao Saheb Ramachandra Rao who, however, considered that with so specialized a habit the seed-fly would not turn to other plants.

It need scarcely be said that we, in Mysore, were inclined to agree with Rao Saheb Ramachandra Rao and were for importation. The opportunity came in 1920 when the writer was sent on deputation. On his way from the States in 1921 he halted at Honolulu and studied the question so far as time allowed. The first thing that impressed him was the very great complexity of the factors involved. In the first place the areas where Lantana appeared to have received check were areas within the limits of the town where, moreover, along with the flies, there were other insects in more or less abundance, viz., (1) The Lantana Tortricid, (2) The Lantana Plume-moth, (3) Leaf bug (*Teleonemia subfasciata*), (4) The Gall fly (*Eutrita xanthochæta*) and other insects. In other parts of the island of Oahu, especially the eastern side where rainfall is heavier, the Lantana appeared to be flourishing and the insects were by no means so numerous. On the island of Hawaii, the only other island visited, Lantana was equally abundant.

As regards the fly itself, the damage it did was more to the pulp of the fruit in which the egg was laid and the larva developed for pupation. The larva usually sought the pithy hollow to be found between the germ cells in every seed. It is obvious that all that is vital to the full-grown seed is left untouched in the attack.

What, therefore, results, in the case of mature seeds is by no means destruction of the seed but the diminution of its

[1] *Mem. Dept. Agri. India, Ent Ser.*, Vol. V, No. 6.

attractiveness to birds and other animals from the destruction of its pulp. The smaller seeds may be injured fatally but the writer came across few instances. The seeds attacked would not be carried far but that is of minor consequence in a country where the problem is the reclamation of land already attacked far more than prevention of spread to new areas. Here again the full capacity of the fly in this limited direction cannot be determined with accuracy because, as believed, it was heavily parasitized. Large numbers of parasites emerged from every jar from which flies were reared out. It is quite possible that in the absence of this serious limitation the flies may prove more effective. It will be seen from these observations that the habit of the fly is after all not very specialized. The question of the liability to attack of teak-seed nevertheless is of little importance because penetration into the thick wall is out of the question. In spite of this fact the possibility was not neglected and seeds from teak trees, of which one was found near the laboratories of the Department of Forestry and the other in the Botanical Gardens, both in close proximity to infested Lantana, were carefully examined for evidence of attack by flies but none was found though several dozens were passed under the binocular. Indeed, there is too little of pulp on teak fruits for the flies to thrive.

As regards the other insect agencies I have already mentioned, the Tortricid caterpillar is certainly the most effective. It tunnels out the flower-heads and destroys them, and as it is found in large numbers, it is certainly very effective—more effective than the fly both in the opinion of Mr. Sweezey and myself. The Plume-moth is already in India. The bug (*Teleonemia*) is also effective, having a blighting effect in Lantana especially in localities where there is moist shade. There is, the writer believes, even greater danger of its introduction into India. The other bug (*Orthezia*) has already been noted in India and is equally dangerous. The Gall fly is a pest among the least important but in some bushes a large number of them were found. A catalogue of insects of minor importance need not be attempted.

There can be no doubt that the check that Lantana has received is in a great measure due to the conjoint action of these various

insects. It is difficult to arrive at a correct estimate of the relative share each has in the total effect or each would have had were their parasites not present. It is even more difficult to disentangle the share of the human factor. American capital and enterprise has wrought a transformation in the course of a generation of the Hawaiian islands embracing every aspect of civilized advancement which it is difficult to put into words. Enormous areas have been brought under scientific cultivation. Plants and animals have been introduced, propagated and spread and the population has multiplied rapidly. These are forces before which Lantana must inevitably have receded, and the further set-back it has received from insect pests should be looked upon as no more than supplemental.

The success that has attended the introduction of the fly into Fiji and New Caledonia must be placed in the same category. The behaviour of an introduced insect under the comparatively limited flora and fauna of small island groups subject to many interferences of rapid settlement and progress in cultivation is of very doubtful value as a guide to the course it would take when introduced amidst the very different conditions of a continent. But the fly has proved distinctly beneficial not only in the islands of Hawaii and Fiji but on the continent of Australia as well where in both Queensland and New South Wales it has helped materially to keep Lantana in check. It is to be hoped, therefore, that similar results may follow its introduction in some at least of the many extensive areas in India where Lantana now flourishes. And the fact that seeds of teak were not found attacked encouraged the hope that the scope for its activity outside Lantana is limited in India. It was in that hope that a consignment was sent by me to India. There having been a through service to India at that time there was no transhipment and no less than 273 flies were liberated in Bangalore, the most careful precautions being taken to exclude the parasites. Unfortunately on none of the bushes they were liberated the flies caught on and no recoveries have been obtained in spite of very careful search. A fresh consignment has not been obtained because through service to India has ceased. But efforts are being made to

obtain supplies from Queensland between which and India no transhipment is necessary. Now that the shipment over long distances has been demonstrated to be feasible, the introduction of the fly is neither difficult nor expensive, and it is hoped that before long the insect will be established in India.

SIMPLE CONTRIVANCES FOR STUDYING ROOT DEVELOPMENT IN AGRICULTURAL CROPS.*

BY

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AND

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Introduction.

That roots of plants—those of agricultural crops in particular—need a careful study is now well recognized, thanks to the marked attention paid to the subject in recent years. Unlike the above ground portions of the plant, whose development and growth can continuously be watched, the roots are hidden from such observation by the opaque soil in which they develop and function. No apology, we believe, is therefore needed for placing before this Congress certain methods which have been found useful in a study of the roos development of sugarcane varieties and seedlings. The methods, though employed by us solely in connection with cane, are capable of being applied to other crops as well with necessary modifications.

Method for studying relative depth and plan of root development.

(*a*) *The apparatus.*

Rings of country earthenware, one foot six inches in diameter and six inches high, are obtained. Any village potter will be able to make them at Coimbatore they are available at Rs. 12

* Paper read at the Botanical Section of the Indian Science Congress, Bangalore, 1924.

a hundred. Two-inch galvanized wire netting is cut into squares, the side of the square being about three inches longer than the diameter of the earthen rings (Plate XIII, fig. 1).

Trenches are dug in the soil, their breadth about twice the diameter of the rings and the depth a little over the maximum depth of the roots of the plant at the stage in which it is intended to examine; the latter is easily ascertained by a few rough dissections in the field.

An earthenware ring is now placed at the bottom of the trench and filled with soil to the top, carefully compacting it by watering at intervals during the filling. A cut piece of netting is then laid flat over the top of the ring. A second ring is next placed over the first and similarly filled with soil. The process is repeated till the trench is filled to the top with the column of rings. Each trench receives many such columns and, when all the columns have been filled with soil, the vacant spaces outside and between rings are filled with soil.

A sett of the cane variety, whose root system is under study, is now fastened either to a layer of netting placed on the top of the topmost ring or to a piece of galvanized wire stretched across it; the former procedure is adopted when it is desired to follow the root development from the earliest stages.

The pot-filled trenches are subsequently cultivated on the surface like any other trench in a sugarcane field in the matter of irrigation and manuring.

(*b*) *Examination of the roots.*

For examining the roots the soil all round the earthen rings are scooped out, planking inserted below the lowest ring in each column, and each column, with the plant inside of it, is bodily lifted out of the trench (Plate XIII, fig. 2). These are now taken to a place nearby where water could easily be commanded and a stream laid on to the topmost ring. The soil inside the rings can now be washed out with comparative ease by removing the bottom planking and assisting the stream of water in its work by poking the soil with bamboo sticks.

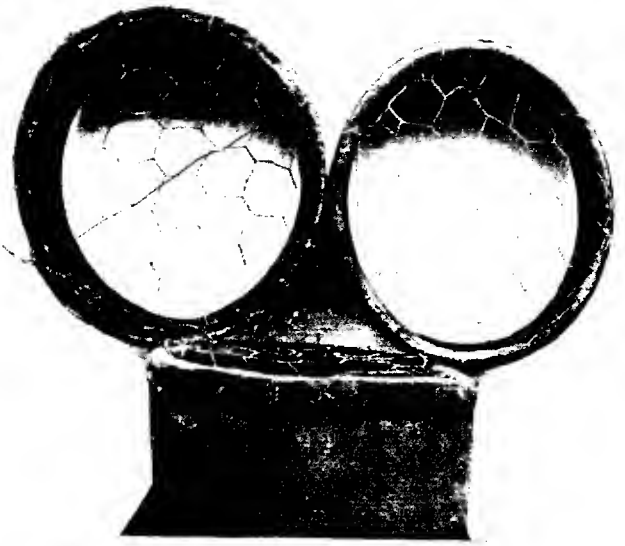


Fig. 1. Earthenware rings with wire netting

Fig. 2. Column of rings.

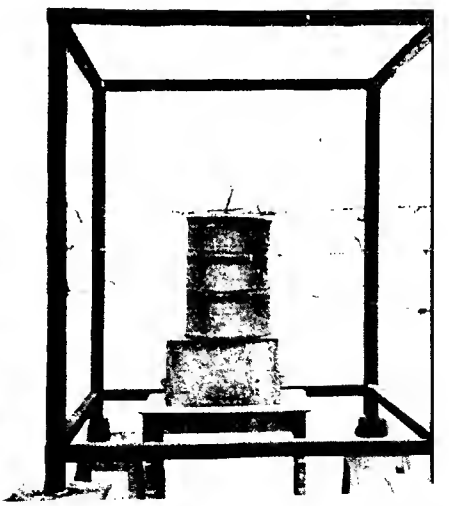
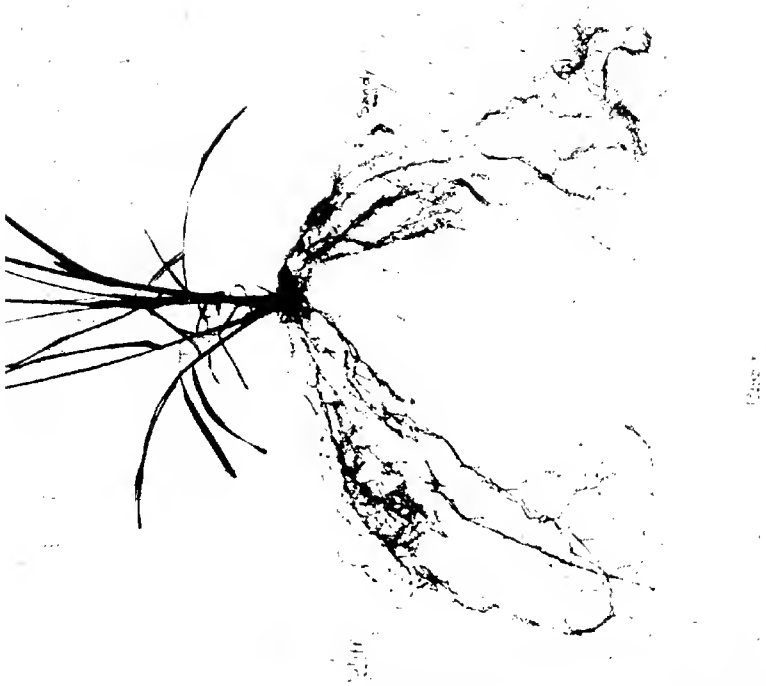
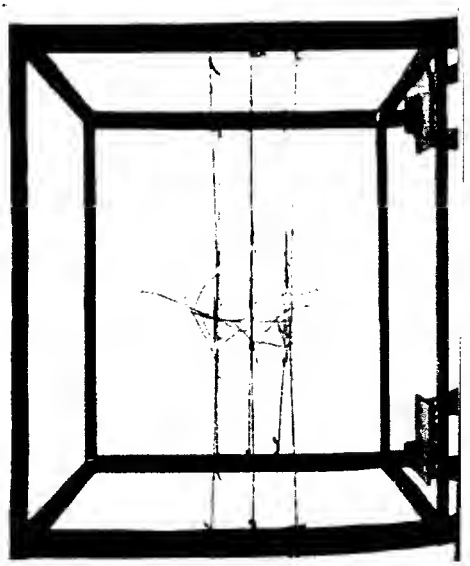


Fig. 3. The wooden frame with a column of rings in

PLATE X





Each column is separately placed in the centre of a bamboo or wooden frame 4′×4′×4′. The edges of the netting, chiefly the corners, are fastened to the frame as tightly as possible (Plate XIII, fig. 3). It will be found that the end rings could now be slipped off without any disturbance to the roots. The rings caught between layers of netting are broken—though after some experience even these could be saved for future use by temporarily unfastening the holding strands and infolding the netting while slipping the rings off. The whole root system of the plant will be found fully exposed with the roots caught up in their original positions or very near them (Plate XIV, fig. 1).

For greater accuracy and for thinner roots half inch netting and finely sifted soil for filling the rings are recommended. The dimensions of rings given above have been found adequate for following root development in canes up to a period of about three months from germination; for more advanced stages wider rings will be needed.

(c) *Uses and advantages.*

(1) By laying down a sufficient number of columns it is possible to follow root development from stage to stage. For this purpose half a dozen to a dozen plants of the same variety and of the same age are lifted out for examination at definite intervals, say, once a fortnight. The reason for examining more than one plant at a particular stage is to rule out individual variations.

(2) The method is fairly fool-proof, as the arrangement ensures the roots being caught automatically in their original positions when in the soil or very near them.

(3) After fixing to the frame the root system lends very easily to photography—a rather important condition for the accurate recording of root development at successive stages.

(4) The method makes possible the study of the effect of different soils on the roots of one and the same plant. This is done by arranging adjacent to each other two columns of rings and filling them with different kinds of soils. The cane sett is placed at the top between the two columns and half of the roots is allowed to

develop in each. Effect of different irrigation waters could also be similarly studied (Plate XIV, fig. 2).

The above method has one disadvantage, however, in that the soil in the bottom rings may not be quite representative of the subsoils in the ground chiefly in texture. But against this it may be mentioned that, in a study of root systems of agricultural crops, the top layers of soil are of greater importance. While filling the rings we have attempted to simulate conditions in nature, by keeping separate the different layers of soil as they are removed from the trenches, filling the rings back in the same order and carefully compacting the soil layers as the rings are laid.

METHOD FOR CONTINUOUSLY WATCHING ROOT DEVELOPMENT—CULTURE SOLUTION IN CHEAP EARTHEN COOKING POTS.

The first method, though useful for recording root development at definite periods, is not suitable when, for any reason, a continuous observation of the roots as they develop is desired; the mass of opaque soil prevents such an observation being made. This was found a disadvantage of considerable magnitude when studying the early developmental stages in the cane. A different method had to be devised for the purpose.

(*a*) *The apparatus.*

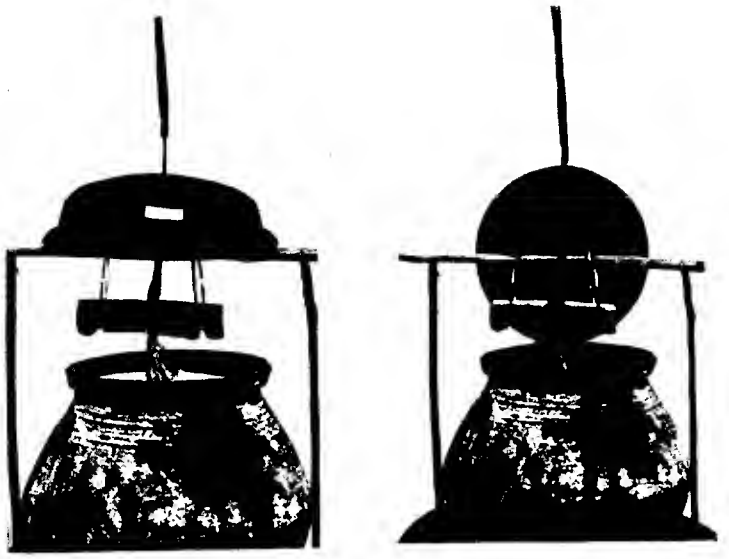
Ordinary country earthenware cooking pots available even in village bazaars at Rs. 6 to Rs. 20 a hundred according to size are employed. The cane sett, whose root development it is intended to study, is suspended into the pot by a pair of glass bangles* from a piece of bamboo laid across the mouth of the pot (Plate XVI, figs. 1 and 2).

The pots are filled with dilute culture solution—we have been using Knop's, but any other might do equally well—till it covers the suspended sett excepting the bud. For sugarcane plain water has been found to serve the purpose during the very early stages. The culture solution is renewed when it begins to smell.

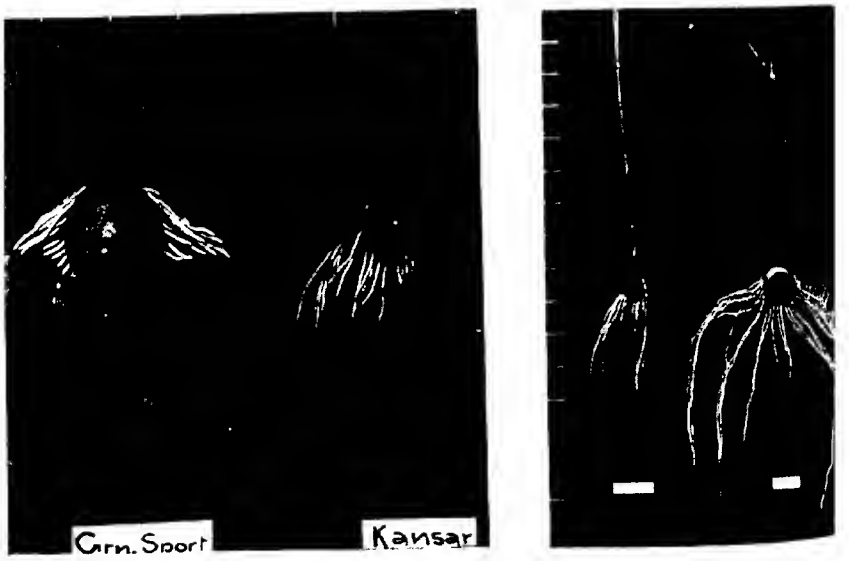
* The bangles used are of the kind available in most Indian bazaars at Rs. 2 a hundred and are of the type usually worn by Indian girls.

Fig. 1.—A batch of cane plants growing in culture solution.

Fig. 2.—Cane plants over seven months in culture pots.



Figs. 1 and 2. Two views of the apparatus used for growing canes in culture solution.



Figs. 3 and 4. Two typical photographs of sugarcane roots from culture solution pots.

The pots with the suspended setts are now arranged in batches according to the variety in the field, the mouths being covered by suitable lids with a hole in the centre for the shoots to grow through. The cane plants develop and grow quite freely in such pots and we have this day plants over seven months old with fully formed canes (Plate XV).

(*b*) *Uses and advantages.*

(1) The articles of apparatus used are cheap and available in most places, two factors which facilitate the laying down of the experiment on a large scale. The growing of a large number of plants is necessary for arriving at satisfactory averages. Costly glass jars or glazed earthenware vessels are not only unnecessary but interfere with the aeration of the culture solutions.

(2) The porous earthenware provides for a free exchange of gases between the solutions and the outside air; in fact, it is found that pouring the solution slowly into another pot and pouring it back each evening is all that is needed by way of aeration of the solution.

(3) The evaporation from the surface of the pot—resulting from its porous nature prevents the solution inside the culture pot getting to a higher temperature than desirable for a satisfactory root development, a common trouble when plants are grown in glass receptacles placed above ground.

(4) The method enables the examination of the roots from day to day and from morning to evening. As the result of such continuous observation unavailable in any other method—certain important differences in the evolution of the root systems of different cane varieties have been revealed (Plate XVI, figs. 3 and 4). One such is the close correlation that has been revealed between the shoot roots of a germinating sugarcane sett and the health, vigour and tillering of the particular plant.

(5) The method enables the obtainment of reliable data on quantity of roots developed; when specimens for weighment have to be obtained from plants grown in the soil, there is always the risk of losing small bits of roots during the washing.

(6) Barring modifications resulting from the roots being grown in liquid media, the process has enabled the securing of different functional regions of one and the same root—from the root cap to the old branching and conducting regions.

(7) The method promises to be useful for studying the development of root hairs. This is done by placing in the solution test tubes filled with glass or pebble sand and allowing one or more of the roots to grow in them.

Selected Articles

AGRICULTURAL CO-OPERATION IN INDIA.*

BY

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If we are to understand correctly the position of the co-operative movement in India, we must attempt to arrive at a proper appreciation of the main factors affecting the lives of the people. Of these, undoubtedly, the most important are the prevailing religions. Out of a population exceeding 319 millions, over two-thirds are Hindus, and more than one-fifth Mohammedans; to the European, the followers of both of these great religions appear to under-estimate the capacity of human energy, intelligence, and enterprise to mould the conditions of life. The Hindu philosophy tends to belittle the importance of material wealth; it seems to attach no worth to material progress and rather inculcates an attitude of passivity to the vicissitudes of nature. In addition to this, the caste system, which many educated Hindus now regard as an unnecessary adjunct, has divided mankind into unchangeable strata, so that not only is a man's position fixed by his birth, but to a large extent his occupation is also predestined for him. Thus Hinduism and the caste system combine to produce a quiescent attitude towards problems of material improvement; human appetites must be denied rather than served by the expenditure of intelligent effort, and human desires must be suppressed rather than pandered to by an elaboration of the standard of living.

* Reprinted from *Int. Rev. of Agri. Eco.*, N. S., II, 1.

Although Mohammedan ideas differ widely from those entertained by Hindus, their effect on economic progress is much the same; the fatalistic attitude towards the world prevents Mohammedans from exalting human achievement, and encourages a passive, resigned state of thought. The prohibition of interest serves to deter them from engaging in banking, and many forms of trade in which interest plays a prominent part, as well as from most forms of capitalistic enterprise. The extreme form of the religious ban on interest discourages all thrift and saving, and nearly all expenditure on productive objects except the land.

This outlook on life, prevalent amongst the followers of both the great religions, appears to receive strength from the extreme dependence of the country upon the monsoon. Over sixty per cent. of the people are engaged in agriculture, and agriculture in India is, for the most part, an effort to utilize the rain that falls between June and October. The monsoon divides the year into two seasons yielding respectively a summer and a winter crop, and both harvests may be ruined by a failure of the rains. Thus while the Hindu philosophy and the caste system serve to dissuade men from that restless search after material wealth which is supposed to be characteristic of the West, and while the fatalism of the Mohammedan tends to make him belittle the importance of human effort in the scheme of life, the beliefs of both apparently receive continuous corroboration from the vagaries of the monsoon, for the outturn of a crop varies less with the skill of the cultivator and the scientific knowledge he brings to his task than it does with the amount and seasonal distribution of the monsoon rainfall.

These broad features account in considerable measure for the fact that while India is naturally one of the potentially richest countries of the world, a large proportion of its inhabitants are desperately poor. It is open to question whether poverty in India, with its joint family system, is ever so acute as in industrial centres in Europe during periods of depression; certainly the existence of a million people in receipt of State relief, which post-war conditions have produced in Europe, would be regarded here as evidence of almost unprecedented famine; in agricultural countries acute

unemployment for long periods is rare, the industry is less liable to violent fluctuations than many of those to be found concentrated in factories and the natural fertility of the soil and the possibility of a harvest every six months limit the period of inactivity. Still the average earnings of the people are low; generations in the past have left no legacy of economic achievement or of material advancement for the benefit of the present. The sinking of vast sums of capital in large public works was almost unknown, so that the face of the land, until the arrival of the British, was very much what nature had made it, altered but little by the creative energy of man. Where famines are regarded as a scourge from above, it were sacrilege to take measures, preventive or protective, to thwart the Divine Will, so that the history of India is punctuated with periods of starvation and distress, continuing, in spite of the efforts of the British administration, almost up to the end of the last century. In such a large country, it was, indeed, seldom that a harvest failed throughout the length and breadth of the land; the successive famines were mostly local failures of the food supply which were accentuated by the imperfect facilities of communication and transport. Alike for the prevention and the relief of these accidents, the country has had to await the introduction and expansion of railways; and these same railways have rendered it possible to encourage the production of food grains in excess of local needs by means of large irrigation works. For many decades the British administrators have steadily applied themselves to the prevention of famines, and most of the bigger productive works have been undertaken with this object. The measures have achieved marked success, so that a famine due to actual scarcity of food is almost beyond the realms of probability; but there may still be severe distress, not from scarcity of food but from inability to purchase it. The cultivator of India tills but a few acres; the habit of thrift is nearly non-existent and the lack of a proper sense of responsibility for his economic future leaves him always unprepared to meet the strain that follows a failure of the monsoon.

It was as a measure of famine prevention that the Government of India undertook to introduce co-operative credit amongst the

agriculturists and persons of limited means, with the hope that by the encouragement of the spirit of thrift and self-help, the economic position of the masses would be so strengthened that they would be able to resist the periodic catastrophes which, in less happy days, led inevitably to famine, starvation and death. To this genesis of the movement is to be ascribed, also, the element of officialism, which is apt to be misunderstood; the Government could not afford to wait for private agencies to arise and organize the people on co-operative lines; periods of scarcity and distress recurred too frequently to permit of time being so lost. The result is that the co-operative movement in India is largely the product of official stimulus and official energy; if to many this official element appears too prominent, the remedy is in their own hands, for in all provinces there are vast fields for the display of unofficial service and public spirit, but the majority of actual co-operators have learned to regard the Government servant as their friend and helper, while, on their part, the officials would deny any tendency to discourage the introduction of private helpers in so large a field.

Repeated Commissions of Inquiry have laid stress on the extent to which the ordinary cultivators are in debt, and this indebtedness has led to a long series of legislative efforts to remove the various causes which drive them to borrow. In order to meet the borrowers' needs, Acts to facilitate loans for ordinary agricultural purposes and longer term loans for land improvements have been passed and amended; the former rigidity of the land revenue payment system has been made elastic; implements, cattle, seed, etc., have been exempted from attachment by Civil Courts for debt; special legislation such as the Encumbered Estates Act, the Deccan Agriculturists Relief Act, the Punjab Alienation of Land Act, etc., has been undertaken; in short every effort has been made to remove the *necessity* of borrowing from the cultivating class. But still debt has risen, and it is only in recent times that the authorities have appreciated the fact that the real cause of debt, here as elsewhere, is the existence of a number of money-lenders anxious to find some outlet for their capital. In India, the habit of

investment in joint stock enterprize does not exist; of the moderate number of companies run by Indians outside the chief cities the majority fail to inspire confidence; there is little competition for the idle capital that exists; there is almost no trust in the public company and there are few of what in Europe would be called gilt-edged securities. The rate of interest paid on Government stock is not sufficiently attractive to a people who even in Vedic times were known as inveterate gamblers; while the lack of business experience amongst the great majority leads to unrealizable expectations of profit from the simplest forms of enterprize. The result has been that away from the great cities, the natural use for spare capital has been regarded as money-lending and money-lending is one of the most profitable industries in the country. No efforts, then, to reduce indebtedness could be successful until the money-lender could be replaced by some alternative system of credit and the one that found favour was that associated with the name of Raiffeisen. If indebtedness was to be driven from the land, the need for resorting to the money-lender must be removed by the substitution of a better agency for financing agriculture. The Indian money-lender seems to have existed from time immemorial; along with trade, tillage and harvesting, it was one of the four honest callings, although it was forbidden to Brahmins. There were various old laws controlling the rate of interest which varied according to the caste of the borrower; the high castes paid little, but those lower down could be charged sixty per cent., and could be made to pay off their debt by labour; the ancient writings mention the sale of wife or children to repay debt. These facts are worth remembering because one of the difficulties in the way of promoting thrift is the attitude towards debt adopted by many of the people. Debt appears to them as customary; a man is born in debt, he dies in debt, and his son takes over the burden along with the ancestral property. A scheme designed to alter this and to banish debt and replace it by savings runs contrary to the accepted order of things which has prevailed since time began. It not infrequently happens that a patient explanation of the advantages of co-operative credit as a means of getting rid

of debt and of substituting thrift is countered with the remark that as the father inherited debt, why should not his son ?

The first Act legalizing co-operative credit societies was passed in 1904; it applied only to credit; in each of the major provinces there was appointed a special official (generally drawn from the Indian Civil Service) known as the Registrar, whose duty it was to organize societies, select and teach instructors, supervise the working of the infant institutions, and have them audited; they were given full powers to inspect and control, which they were expected to use with the sole aim of assisting the societies to learn to dispense with this form of help. In the early years, progress naturally was slow; not only were the Registrars themselves untrained, but the amount of literature in English on co-operative credit was at that time very limited. Fortunately, however, the officials selected were fully imbued with a sense of the fine opportunity afforded to them to labour in the cause of the poor cultivators, and conscientiously set themselves to learn and teach. It was, however, unfortunate that none of them had had any practical experience of the actual working of co-operative credit in Europe, and they had no non-European types to study, and no guidance from experts who knew the conditions both in Europe and India. In spite of this, very substantial success was achieved which reflects the highest credit on the officers responsible; but by 1913 it was considered desirable to review the situation and a special Committee was appointed to tour India and examine the progress made and to study the methods adopted in the various provinces. This Committee published a valuable report, known as the Maclagan Report from the name of the President, Sir Edward Maclagan, now Governor of the Punjab. In this valuable work, there was embodied a series of recommendations which have now for the most part been incorporated into the movement, and which have undoubtedly served to place the credit societies in a sound financial position. The original Act of 1904, which had provided only for credit, had already been replaced by another in 1912, which permitted other forms of co-operation than credit and made provision for secondary societies. In its general outline the law follows closely the English Friendly

Societies Act; it embodies certain essential conditions of the Raiffeisen society, which are compulsory for rural banks, but it leaves to Local Governments the framing of subsidiary regulations by giving them a rule-making power upon many of the matters which find place in Acts of other countries, such as Germany. Speaking broadly, all Registrars have studied closely the various European systems and have, in particular, derived great benefit from Cahill's Report on Co-operation in Germany, and have followed German example in the drafting of these rules as well as in the by-laws. State aid is less prominent than in most European countries as the example of English Consumers' Co-operation is adhered to; the concessions are the usual exemptions from Income Tax, Registration Fees, and Stamp Duty. In two important particulars, the Indian Act differs from those of nearly all countries; one is that the Registrar has power to refuse registration of a society until he is satisfied that it has a fair chance of becoming successful; and the second that he can cancel the registration and so force a society into liquidation. Both these powers are designed and are used to ensure a high quality of work within the society, and to build up public confidence in co-operative credit.

Under this Act, there are at present about 47,300 primary credit societies registered: of these, the vast majority (45,000) are rural banks with unlimited liability on the Raiffeisen model; these differ but slightly in the different provinces, and may be roughly classed into those with and those without shares. The share type originated in the Punjab at the suggestion of the people themselves; the members subscribe a small sum, not less than one rupee a year, and generally two rupees or more, for ten years in order that their owned capital may be the greater and that they may enjoy the sooner the advantages of independence of outside borrowing. At the end of ten years, this share money may be disposed of in any one of several ways as may be determined at a general meeting; it may be returned to members, or it may be converted into even permanent shares of, say, ten rupees each, the sum in excess of this being returned; or it may be made into non-returnable shares without being evened off. Where it is returned to members,

these in some cases begin afresh to subscribe for another ten years. The accumulated profits are dealt with in a similar variety of ways. They may be converted into non-returnable shares, in place of or in addition to the other shares, or they may be kept indivisible for ever; at least one-fourth must be kept as indivisible reserve. Thus after ten years, many share societies become pure Raiffeisen; others distribute profits up to a maximum of 9 or 10 per cent. in the twelfth and succeeding years; others retain shares with indivisible profits. Generally speaking, Mohammedan societies prefer indivisible profits, while Hindu and Sikh societies incline to dividends in the twelfth year. It is unfortunate that the term "shares" has been used in connection with these small sums. They are in no sense a measure of a member's stake in the society; they do not affect his unlimited liability; they are not shares in the joint-stock sense. On the other hand, they differ from compulsory deposits in that, on liquidation, they rank after deposits, so that a deposit would be repaid, if need arose, from shares before any call would be made on the unlimited liability. They are best regarded as a small paid-up portion of the unlimited liability. The great advantage of these small shares is that the owned capital is rapidly built up; the share-money as well as the accumulated profits is used in the business of the society, and earns interest; the result is that in most societies, independence of all outside financing agency is attained in fifteen years, and in many cases in ten years. It is objected that this independence has its drawbacks inasmuch as it leaves the society too free from control from the superior secondary institution; while another objection is that where the owned capital is large, the members are apt to borrow in excess of their real needs. In many parts of the country, the share system is unpopular and so has not been introduced. Where the share system does not exist, societies follow the Raiffeisen model, with unlimited liability and indivisible profits; in some places, an attempt is made to introduce a system of compulsory deposits in order to encourage thrift and set funds free for further expansion.

With the exception of Bombay Presidency, the rural credit society is a small unit with from 20 to 30 members, and with a

working capital of about Rs. 2,600, or roughly Rs. 90 per member; in Bombay, the membership is about 74. Of the working capital, usually very little is contributed by members; outside Bombay and the Punjab, members' deposits amount to very little. Under the Act, all profits of societies with unlimited liability are indivisible unless the Local Government otherwise directs; most Governments have kept profits indivisible for ten years, so that there is a steady piling up of a very valuable reserve which now amounts to nearly 150 lakhs of rupees. This reserve is largest where the share system has been longest in force, as all profits resulting from using the share money in the business of the society are added to reserve; thus this fund amounts to 57 lakhs of rupees in the Punjab, where nearly half the sum on loan to members is covered by their savings in the form of shares, profits or deposits. It is this financial strength following on the adoption of the share system, which is inducing other provinces to popularize the same measure.

The actual working of the societies throughout India is very much the same. A committee of management is elected by the members and is responsible for the ordinary business; it is guided and bound by a careful scheme of by-laws drawn up by the Registrar; these by-laws are based upon the Raiffeisen model, with modifications to suit local conditions; they cannot be altered without the Registrar's consent, as every amendment has to be registered and he has power to refuse registration to objectionable changes. According to the recommendations of the Maclagan Report, every society is supposed to agree in general meeting upon the sum which it can borrow from outsiders during the year; that is to say, the society places a limit to the liability it is prepared to incur. This is known as the normal maximum credit; in some provinces, Assistant Registrars check this and inform the financing agency, as well as the society, of the sum they consider reasonable in view of the requirements of the members. Within the society every member is usually given a fixed maximum credit which the committee cannot exceed without the sanction of the general meeting. Within these limits, the committee accords sanction to loans to members; these loans, in the peculiar circumstances of

India, cannot be confined to productive purposes, but the essential of "necessity" is usually insisted upon, that is to say, a member is allowed to borrow for expenditure which the committee regards as necessary in view of the ceremonies the member has to perform. A persistent attempt is being made with promising results to impose a limit to expenditure on marriages, funerals and other objects which religion or custom demand; but when it is remembered that extravagance upon marriages is regarded by many observers as the most important cause of debt, the difficulty of controlling this item will be appreciated. The great difficulty facing all attempts to diminish expenditure on these ceremonies is the existence of the money-lender always ready and anxious to lend what the society refuses to advance. The problem is too intricate to yield to summary treatment, but steady persistent teaching, carried on with unending patience by the staff of the Registrar, is beginning to yield benefits in some parts. The chief objects for which loans are advanced are repayment of old debts (everywhere a large item), marriages, seed, fodder and cattle and the payment of land revenue. This last item represents chiefly the assistance afforded to the cultivators to hold up their produce for better prices while still enabling them to meet the government demand. Less important objects numerically are land redemption, land improvement, sinking of wells, rent, land purchase, and purchase of agricultural implements. In every province, the need for the repayment of old debts is a serious problem which cannot be neglected. These old debts usually carry a high rate of interest; experience has shown that to lend sufficient to enable the member to pay them off at once does not always lead to good results as the member, relieved of the crushing burden of interest, seems to lose the incentive to repay the society. On the other hand, to refuse help in repayment is still more unsatisfactory: the usual course adopted is the middle one of offering to lend a portion when the member is prepared to make a real effort to pay up the balance. It is the existence of these old loans which hampers progress, and prevents concentration upon direct economic advancement; unfortunately, there is nothing to prevent a weak member from returning to the money-lender if the society, for good reason,

refuses to provide money for extravagance. Similarly, it is felt that too great strictness in enforcing repayment of a society's loan would drive members back to the money-lender. The latter is always ready to oblige, trusting to the Indian idea in regard to ancestral debt; his rates of interest are so high that he can afford to risk loss of principle, while the prosperity developed by British rule has placed in his hands a large sum for which he can with difficulty find investment. On the whole, the movement is making steady progress: the number of agricultural credit societies has increased in the last five years for which figures are available from 23,000 to 45,000; membership has similarly increased from 851,000 to 1,516,000, and working capital from 689 lakhs to 1,332 lakhs of rupees. That there are grave defects, no one realizes better than the Registrars and their staffs, and no one works harder to eliminate these defects. Their task is made harder by the peculiar conditions prevalent. Illiteracy is the rule: where in Europe, the squire, the doctor and the priest will be found helpful and sympathetic, in India all will be illiterate and generally reactionary. The extreme dependence of agriculture upon the monsoon and its vagaries prevents regular repayment: religious feelings are responsible for the absence of animal husbandry, and of many of the subsidiary occupations which add to the family income in Europe; caste feeling prevents the keeping of poultry except by those of low caste, and sericulture is similarly regarded askance by the petty owners as something only fit for those beneath them; generally there is no alternative industry to which the people resort when not occupied on the land; rural industries are for the most part the work of menial castes; in many parts of the country, the women are not allowed to work in the fields, and nowhere do the women contribute to the household income to the extent common in Europe; past conditions of insecurity and religious beliefs have combined to stifle the idea of self-help and to limit provision for the future; the standard of living is low and easily satisfied, an addition to the income is usually offset by a reduction of work; at the same time, there are certain customs and ceremonies which involve expenditure out of all proportion to the means of the cultivators and which are

readily catered for by the ubiquitous money-lender. In extensive tracts, the land is in the hands of large owners, who are apathetic to the interests of the tenants and sometimes even antipathetic to any measure that promises to raise them from their economic serfdom. Finally, there is a remarkable lack of economic organization into which the co-operative movement can fit. The most striking element in the economic life of India is waste. But when an attempt is made to remedy this by co-operative organization, it is found that a single society or even a small group can do little; not until the whole machinery of rural activity is properly organized on co-operative lines will there be scope for many forms common in Europe. This is particularly noticeable when an attempt is made to organize societies for purposes other than credit; everything has to be organized from the very bottom. It may be objected that the very necessity for numerous societies required to meet the poverty of the people serves to hinder a healthy growth; there is an insistent demand from the people themselves; there is a body of conscientious officials only too anxious to do whatever may be possible to provide relief from the intolerable burden of debt; between the two there arises a tendency to start societies without sufficient preparation, and it is here that the power of the Registrars to refuse registration becomes valuable. In order to build up for the co-operative idea a sound reputation amongst the public, it is essential that no depositor should lose his money, and in consequence financial soundness is insisted on. It is usual for societies to be classified as "good," "fair," "average" and "bad" upon the basis of the annual audit, and it is the Registrars' custom to insist upon regular inspection of all societies classed as bad and to direct compulsory liquidation where the members show no inclination to remove the defects brought to light. This power to bring about liquidation extends to all societies whether organized by the official staff or by non-officials; the work of liquidation is extremely troublesome, and in consequence Registrars freely exercise their power to refuse registration to societies until they are satisfied that the applicants have been properly instructed in co-operative principles and in the business of credit, that sufficient and efficient supervision will be

available, that honest office-bearers have been elected, and that the members are not merely willing to borrow from the financing agency but are prepared to put forth the moral effort required to raise them from the serfdom of debt. This official supervision and control is frequently misunderstood, but the fact that all Registrars constantly find societies securing registration which were quite unfit for it shows that it is not excessive. In a similar way, too, the need for rapid progress militates against the full development of the right spirit. To finance the new societies, funds are constantly needed; if the members were left to their own resources, to raise funds from amongst themselves and their neighbours, too much time would be lost. The result is that central banks are encouraged to come to the help of new societies, and this undoubtedly serves to remove from the members the necessity of securing local confidence in order to secure local deposits, and also of striving to develop thrift amongst themselves. The distant central banks cannot exercise that close supervision over the societies which neighbours with money in deposit can; and the members lose that moral training involved in building up confidence by slow and painful stages.

It is to fill up this gap that in some provinces what are called guaranteeing unions have been organized. Their chief functions are to relieve the central banks of the detailed work of inspection and supervision, to pool their securities and redistribute their total credit amongst their constituent societies, and, in order to protect these from loss due to the misconduct of any one, to ensure thorough training and instruction in duties and responsibilities. Each union is composed of a small number of primary credit societies, and its managing committee is elected from the members of these societies; this committee assesses the credit of the constituent societies and informs the central bank of its decision and undertakes a certain amount of responsibility for securing repayment of any loan from a central bank to a society advanced in accordance with its recommendation. Thus each society accepts a certain amount of responsibility for the repayment of loans to other societies in the union, and so has a motive for insisting upon sound

working. In actual practice this responsibility appears never to have been enforced, so that it is difficult to say how far the system would stand a strain; but these unions have aroused much enthusiasm amongst their supporters in Burma and some provinces of India, and have also incurred severe criticism from the veteran Mr. Wolff. In some cases, the Registrar admits that they are purely nominal, that the committees do not appear to realize their responsibilities and that the principle underlying them is not understood. Their greatest success has been achieved in Burma, where the idea originated, but they have been pronounced successful in several provinces of India as well. There appears to be no doubt that if the committee can be induced to perform their responsible duties, these unions can be of great benefit to the movement. In some provinces, they are replaced by banking unions of which some account will be given in another article.

Before leaving this side of the movement, it may be remarked that hitherto, large though the numbers are, the credit societies have only touched the fringe of the great problem of rural indebtedness. They have afforded ground for hope that a way of escape has been discovered, that the Indian cultivator can get out of debt whenever he is prepared to make a real effort at self-help and thrift, and that borrowing from the money-lender is not the necessity which some Indian writers prefer to believe. At the same time, it must be admitted that co-operative credit is not likely to rid the country of the great burden of useless debt which encumbers agriculture; there are many devoid of the desire to put forth any effort at self-improvement; many lack the character which is essential to success; many lack the strength of will; many are too selfish, and having got rid of their own debts with the aid of a society resign and leave their neighbours to their fate; others are too weak to resist the wiles of the ever-present money-lender, and sink back into his toils as soon as the society attempts to recover loans from them. The movement is achieving great success, but it is too young yet to replace age-old customs; a new generation must spring up unaccustomed to money-lenders and accustomed to regard their society as the financing agency before it will be time to pronounce a verdict

upon the co-operative credit movement in India. The magic works in congenial soil here as elsewhere; but there are many who do not desire economic uplift, who are content with the ample leisure which the satisfaction of their simple wants leaves them, and who will not throw off the easy habit of reliance upon nature when nature is bountiful and on the money-lender when she is not.

Considering the small number of years during which systematic effort has been made to inculcate the co-operative idea into the minds of the cultivating classes, the success achieved has been remarkable, and although it is undesirable to put forward extravagant claims, there is good ground for believing that a continuation of these efforts on the same lines would bring vast benefit to the country; whether the changed political conditions will permit of this is a question outside the scope of this article.

In India, as elsewhere, the credit society has been found a valuable starting point for further experiments in co-operative enterprize. The ideas of self-help and mutual help are easily taught in credit work and, once well imbibed, can be directed into other channels. In the last five years the variety of experiment has been remarkable; the number of agricultural societies for objects other than credit has increased from 272 to 1,165, but as most of these have been organized in order to test the prospects of success, the variety is more important than the number. One of the earliest experiments was in cattle insurance in Burma; it attained a certain amount of success owing to an element of compulsion, but it is doubtful how far the type will last now that this element has been withdrawn: the only other province in which this experiment has been tried on any scale is the Punjab, and there the efforts of the staff to popularize the measure have only met with a moderate response. In both provinces, the societies have been confined to a few districts and there has been no demand for extension. Cattle mortality of a preventable nature is very high in India and Burma; religious feelings prevent systematic elimination of the less fit, so that there is apt to be a surplus of weak animals, which succumb to disease and serve to spread contagion around. Preventable mortality is one of the most frequent causes of borrowing,

and cattle disease and fodder famines are probably among the chief factors in rural debt, so that a popular system of insurance would be a great boon; but the idea of providing for future contingencies, in a country where the money-lender is so ready to offer assistance, is poorly developed and it is doubtful whether any insurance would survive the withdrawal of official help and stimulus.

All over India, the necessity of extending co-operative activities to objects other than credit is fully appreciated by the Registrars and their staffs, and sustained efforts are being made to develop these societies. Those which at first appeared to promise most success were for purchase and sale; societies for providing manure, agricultural implements, seed, and simple household needs, such as cloth, have been organized in almost every province; in some cases there are separate primary village societies for these purposes; in others, the primary credit society is the actual distributing agent, while their supplies are obtained through supply unions constituted from societies. Opinions differ as to the advisability of multiplying primary societies in Indian villages where the number of men qualified for the committee is so small; in Bombay, complete separation of finance from supply is advocated; in the Punjab, it is held to be useless to register two societies in the same village which are the same in everything except the books and the object. Throughout India, there is a distinct tendency for supply societies to decline. For this two causes are assigned; an Indian Registrar of Bengal voices a general opinion when he remarks that "there is, perhaps, in the Indian Mufassal (rural areas) a greater difficulty in finding a capable management for such societies than in Western countries": while another reason is that the difference between the nominal wholesale and retail prices is smaller than in Europe. The Indian retailer depends for his profits less upon difference in price between his purchases and his sales than upon adulteration, short weights, and similar devices. Further, the Indian shopkeeper is frequently also the money-lender, and manages to keep his clients loyal to his shop by involving them in the toils of usury. The idea that he makes large profits from retailing petty household necessaries is probably incorrect; he earns something by usury,

something by making his clients sell their produce to him at rates fixed by himself, and something by cheating in weighments, etc. Where a society has made a good beginning with the co-operative sale of cloth, etc., it has happened that a selfish member, having learnt how to follow suit, has started a shop of his own. One important obstacle to success, undoubtedly, is the habit of giving credit and so of expecting it. A private shopkeeper prefers to sell on credit as he keeps the accounts himself and adds his own interest, and the co-operators are not yet sufficiently educated to understand that the co-operative ideal of sales for cash is really of great benefit to them. It would appear that the idea of joint purchase is still too new for a custom-ridden people; while there is also some truth in the opinion that the Indian people have not yet felt that cruel grinding poverty which drove the working classes of Europe to organize stores on the Rochdale plan and which still prevents many of them from joining stores that insist on cash payment.

Societies for co-operative sale have met with somewhat better success, but failures and set-backs are recorded from most provinces. The sale of the higher grades of cotton has been pushed at the instance of the Agricultural Departments which discovered that it was useless to induce the cultivators to sow better seed, or better varieties, if they could not get a higher price for the better lint. Cotton auctions were organized with some success but from north to south came the tale of rings of middlemen combining to refuse to bid; the big buyers refused to attend, the commission agents attended but preserved strict silence. It was in consequence of such experience that in the Punjab there was started a new type of co-operative sale society; as the buyers would not come to the auctions, it was decided to invade the enemy's camp and establish co-operative commission shops in the chief markets. The scheme took shape in the prosperous Chenab Colony at Lyallpur; a shop was rented in the market and a society containing both individuals and societies as members was organized. The society members might be sale societies, but are mostly for ordinary credit, so that the members of the village bank secure the advantage of membership in the commission shop without joining as individuals.

Members take their wheat and other produce to their commission shop where they learn what the current market price is; if there is a demand for immediate sale, the produce is sold on a commission basis; if demand is slack, the produce can be stored and the cultivator is allowed up to eighty per cent. of the estimated value on the security of the stock, the balance being paid when the produce is sold. Here again, the obstacles were of an unexpected nature; the agents and merchants, including the representatives of the big European exporting houses, boycotted the shop; that was expected and surmounted; but it was found that the profits of the other agents in the market were not derived so much from commission sale as from a large money-lending business carried on with their clients under the guise of forward sales. The various commission agents advance large amounts to the cultivators on the promise that future years' produce shall be sold through them; this is attractive to the easy-going cultivators who seem unable to calculate the total loss suffered by them through the various charges for interest, weighing, commission, and a whole series of miscellaneous items. The agents, for instance, charge for unloading and loading from carts, but they pay regular labourers for this and pocket the profits. Then a fruitful source of gain is short weighing; although both co-operative commission shop and the market agents may offer the same price by weight, the former pays a considerably larger sum as it pays on fair weights. There appears to be hope of success for these shops, which are spreading and becoming more popular.

Conditions vary so greatly throughout India and Burma that it is only to be expected that types of agricultural society should vary too. In one province, Bihar and Orissa, what are termed grain *golas* have achieved a considerable measure of success. Each member has to contribute a fixed quantity of rice per acre held for five years; the idea is to store grain to fight famine and scarcity, and promote the habit of thrift. The grain stored may be lent out, in which case repayment is made in kind; it may be lent for seed or for household consumption. What is not immediately required is stored in mud houses with fire-proof roofs;

portion of the material is provided by Government while the members undertake to give free labour. The idea appeals to simple people when the proposal to save money would fall upon deaf ears.

In Madras, some success has been achieved in the co-operative industrial sphere, by the establishment of co-operative societies for rice-hulling, groundnut decorticating, etc., but members still appear to lack confidence in joint sale. In Bengal, this lack of confidence has unfortunately found support in the dishonesty of the management of one or two sale societies, but a number of associations for the sale of members' milk have attained satisfactory results and give ground for the hope that the milk supply of the large city of Calcutta can be organized on a co-operative basis by tapping sources of supply outside the city. Already the societies provide a pure supply while securing for the producer a better price; what this means will only be realized when it is understood that practically all milk sold in India is adulterated, and that municipal regulations designed to prevent this have completely failed. Bengal possesses one of the most remarkable instances of success in co-operative sale in a society of *ganja* cultivators; the cultivation of this plant for production of the hemp drug is under the close control of the Excise Department; the society is composed of the actual growers, and so has a monopoly of trading; the Excise Department fixes the sale price. The chief effect of the organization of the society has been to get rid of the middleman who used to treat the cultivators as he pleased, and to save for the members all the profits on the sale of the drug. These profits have proved to be very great and they are being devoted to the moral and economic uplift of the cultivators; sanitation, medical aid, education, veterinary aid for cattle, improvement of roads, etc., are all being paid for out of the surplus saved by co-operation, and the Registrar is able to record a marked development in the sense of self-help and self-respect. Bengal, again, is experimenting with some interesting types of societies for providing irrigation facilities. The members show no reluctance to subscribe share capital for the construction of small irrigation works, which are proving

valuable investments in districts with precarious rainfall. In the Central Provinces the most successful effort, outside credit, has been the seed unions whose main object is the supply of good pure seed to members; these unions also sell agricultural implements.

The Punjab has, perhaps, the greatest variety amongst societies for the improvement of economic position of agriculturists. In that province a systematic survey has been made of the factors retarding prosperity, and societies have been designed to eliminate these. In addition to many societies of types already mentioned, the province had a number organized with the object of diminishing the volume of litigation which is such a curse to the peasantry; these arbitration societies were making satisfactory progress when they were all summarily closed down under orders of the Minister for Agriculture. Societies have been formed to own and work seed and demonstration farms, to improve cattle-breeding, to reclaim waste lands, to clear silt from the inundation canals, to improve sheep-breeding, and to provide night schools where the illiterate peasants can acquire the elements of education which they neglected to obtain in their youth; there is also a small land mortgage bank, but, perhaps the most interesting experiment is the formation of societies for the consolidation of scattered holdings. Fragmentation of the small holdings is a serious evil in the Punjab as elsewhere, and these societies are being formed amongst the owners in a village to encourage readjustment so that each owner may have his land in one or two compact blocks instead of in thirty or forty scattered throughout the village area.

From the above it will be seen that India is reproducing types that have proved useful in other countries as well as starting types of an original kind. The Registrars and their staffs are constant students of the movement in other countries and endeavour to the limit of their ability to introduce whatever seems likely to yield good results. The improvement of agriculture by the supply of better seeds, of better implements, by organizing special agricultural associations for discussion of new methods, etc., is accepted as the duty of the departments. Under the peculiar circumstances

of India, it is inevitable that so much should be in official hands. Rural leadership, where it exists, is of a modest and rather primitive type, but the co-operative movement is undoubtedly developing this into a powerful factor in the economic uplift of the masses of the people. Already, results of note have been achieved; men possessed of public spirit have been encouraged to come forward and work for their fellows; others with leadership dormant within them have been given the opportunity to disclose their latent capacities; in a movement so young it is unnecessary to make claims at this stage, but there are signs that the poor cultivators in more than one province are beginning to realize that through Co-operation there may be attained emancipation from debt and poverty, freedom from the crushing burden of an army of greedy usurers, liberty of choice in production and sale, a fair field, and a fair opportunity for the manhood that is in them.

ELEPHANT GRASS (*PENNISETUM PURPUREUM*, SCHUM.).

BY

O. STAPF.

In the "Rhodesian Agricultural Journal" for June 1910 (Vol. VII, p. 1398), a new fodder grass was described as Zinyamunga or Napier's fodder. It was referred to *Pennisetum*, and compared especially with *P. spicatum* (*P. typhoideum*), the well known pearl millet. Last autumn specimens of the grass were received at Kew and later a chemical analysis of the stalks and leaves was sent by Mr. H. Godfrey Mundy, Agriculturist and Botanist of the Department of Agriculture, Salisbury, Rhodesia.

The grass was easily identified as *Pennisetum purpureum*, Schum. (*P. Benthamii*, Steud.), a species of very wide range in Tropical Africa; but, common as it is, very little is known about its life-history and uses, and even its limits as a species and its differentiation into varieties is not settled. It will, therefore, be useful to gather in a brief account all that is at present ascertainable about the grass.

Definition of the species.

A tall perennial grass with a creeping rhizome (*Barter*). *Culms* erect, in tufts of up to twenty, usually 2–3 m., or occasionally up to 7 m. high and 1·2–2·5 cm. thick at the base, branched—particularly upwards—with the branches obliquely erect, terete, glabrous, smooth, excepting the uppermost internode, which is more or less hairy to tomentose in the upper part, the exserted parts sometimes covered with a glaucous bloom; nodes mostly exserted from the sheaths, all glabrous or most of them or only the uppermost with a ring of stiff long adpressed hairs. *Leaf-sheaths* terete, clasping the stem, striate, usually glabrous and smooth or more or less pubescent

* Reprinted from *Kew Bull.*, 1912.

to hirsute with tubercle-based hairs near the top; *ligule* a narrow rim bearing a dense fringe of white hairs up to 2 or 3 mm. long; *blades* linear, not or slightly attenuated at the base and inserted on the sheath with a very marked hinge-fold, very long, tapering upwards to a fine point, 30–60 (rarely to 90) cm. long and up to 2·5 cm. wide, with a strong midrib, rounded on the back with a shallow channel above towards the base, and in the larger leaves with six or seven slightly prominent primary nerves on each side, dull green, sometimes slightly glaucous or faintly tinged with purple, more or less rough on both sides, glaucous beneath, usually more or less hairy above, particularly towards the base which sometimes becomes fringed, hairs fine, mostly rather stiff and long and often springing from small tubercles; margins spinulously scabrid, the spinules sometimes very firm and sharp. *Inflorescence* an erect, dense, cylindric spike, from 8 to 20 and even 30 cm. long and 1·5–3 cm. wide, usually yellow or tinged with brown, purple or quite blackish-purple, made up of deciduous spikelets or fascicles of spikelets, each spikelet or fascicle surrounded by an involucre of numerous bristles of unequal length, most of them 5–8 mm. long, one usually very much longer (1·2–2 or exceptionally to 4 cm. long), scabrid, one or several of the innermost and longest sparingly plumose towards the base, rarely all naked, often dark yellow, brownish or purplish towards the tips or blackish-purple from the base. *Spikelets* sessile or if in fascicles of 2–4, the lateral pedicelled, all lanceolate, more or less acuminate, 5–7 mm. long, glabrous, straw-coloured or tinged with brown or purple towards the tips of the florets, rarely blackish-purple all over, ♀ or, if fascicled, the lateral ♂, rarely neuter or all ♀. *Lower glume* suppressed or quite rudimentary, upper ovate to ovate-lanceolate, acute, 0·5–1 (rarely to 2) mm. long, subhyaline, 1-nerved or nerveless. *Lower floret* ♂ or more often barren; valve lanceolate, acute or acuminate, half as long to almost as long as the upper floret, more or less distinctly 3-nerved, rarely 1- or 5-, or even 7-nerved; palea linear-lanceolate, 2-nerved, shorter than the valve or in the barren florets much reduced or suppressed. *Upper floret* ♀ or in the lateral spikelets ♂;

valve lanceolate, acuminate or rostrate-acuminate, very minutely scaberulous upwards, usually 5-nerved, nerves more or less prominent towards the tips; palea narrow, linear-lanceolate, slightly shorter than the valve, tips minutely 2-toothed. *Lodicules* 0. Anthers 2·5–3 mm. long, tips very minutely penicillate. *Styles* united all along; stigmas very slender, up to 4 mm. long, exserted from the tip of the floret. *Grain* unknown in the mature state; almost mature obovoid with a large orbicular hilum and an orbicular-elliptic scutellum.

As will be seen from the description, several of the characters, such as the amount of indumentum, the number of spikelets in each partial inflorescence and their sex, the colour of the bristles of the involucre and the florets and the relative length of the glumes and valves and their nervation, vary within considerable limits. These variations appear to be independent of each other, and also to be unrelated to the geographical distribution. The most that can be said from the material at hand is that, on the whole, the nodes are usually bearded in specimens from the north-western and northern parts of the area, and usually glabrous in those from the south and south-east. But perfectly glabrous nodes – glabrous from the beginning—may be found along with bearded ones in the same plant, when it is generally the lower nodes which are glabrous. The hairs which form the beard of the nodes spring mostly from the top of the internode and cover the annular sheath-joint, which itself is glabrous. Their distribution around the joint is frequently unequal, and on the older nodes they finally rub off. The waxy bloom so distinct in some samples is mostly confined to the upper parts of the internodes, but may also be seen on the backs of the blades and sheaths although it is much fainter there. This character too is apparently unconnected with others and does not coincide with definite divisions of the area. The purple or bronzy colouring of the inflorescence is just as erratic; but really dark spikes, blackish-purple all over, are rare. When the partial inflorescences are unispiculate, the spikelets are always bisexual with or without a male flower in the barren floret; but where there are two or more spikelets in a fascicle, the tendency is towards a reduction of the

sexual organs in the outer spikelets, so that their upper floret becomes male and the lower neuter or, in extreme cases, both are neuter. This reduction may or may not be accompanied by a slight increase in length and nervation of the valve of the lower floret and sometimes also of the upper glume. Those fluctuations are generally found within the same inflorescence, the lower partial inflorescences being frequently 2–4 spiculate, whilst the upper are 1-spiculate, or they may only become evident by comparing different specimens from the same gathering. They are probably due to varying conditions of nutrition either within or without the plant, or may be due to sporting tendencies, in which case they might be expected to run through many generations and constitute more or less constant races. To sporting or mutation I would also trace the apparently erratic variation in the length of the bristles of the involucre, and especially of the longest, and in the degree to which the inner bristles are plumose, a character which is never very marked in this species and may even completely fail.

Considering the instability of all these characters it is clear that the discrimination of subordinate groups other than sports or mutations within *P. purpureum* in so far as it is based on them must result in the production of artificial divisions and can serve no useful purpose. I refrain therefore from subdividing the species or taking up Hackel's varieties *sambesicense*, *nudum* and *ternatum*,[1] and even doubt whether Leeke's species *P. flavicomum*, *P. pruinosum* and *P. pallescens*[2] can be maintained, as all the distinctive characters which he adduces seem to come within the limits of fluctuation just described. Unfortunately Leeke omitted to quote the specimens on which he bases his species, nor does he give any indication of their habitats except in the most general terms, as East Africa or Togo; but so far as they go, the species cited occur entirely within the area of *P. purpureum*.

As to the name *P. purpureum*, this was given by Schumacher to a plant collected by Thonning on the Gold Coast in the latter

[1] In Schinz, Plantæ Menyharthyanæ in *Denkschr. Ak. Wiss. Wien*, Vol. LXXVIII, p. 400.

[2] Leeke, *Abstamm. u. Heimat. d. Negerhirse*, pp. 45–47.

part of the 18th century. A specimen from the same collector and answering exactly Thonning's description came from Vahl's herbarium through Nolte to the British Museum, and it may be taken to constitute a cotype. Rendle[1] has already pointed out that it is identical with Bentham's *P. macrostachyum*,[2] which, owing to there being already a *P. macrostachyum* by Brongniart, was renamed *P. Benthamii* by Steudel,[3] a name until recently very commonly used for the grass which is the subject of this article. In fact, Bentham himself was quite aware of the probability of the identity of his and Schumacher's species, but was misled into describing the grass he had before him on account of the absence of the purple colouring insisted upon by Schumacher. We now know that no importance attaches to this as a taxonomic character. As to the other synonyms to be referred to *P. purpureum*, one *P. nitens*, Hack.[4] rests on *Gymnothrix nitens*, Anderss.,[5] and represents a robust yellow-spiked state, common in South East Africa, whilst the other *P. flexispica*,[6] K.Sch., was based on East African specimens which happened to have a more slender and therefore more flexible rhachis.

Distribution.

The area of *P. purpureum* lies between 10° N. Lat. and 20° S. Lat. The northern limit runs from Sierra Leone through the great equatorial forest belt to the Cameroons and the basin of the Ubangi, then to the Nile (at 3° N. Lat.), Lake Victoria and German East Africa, where it reaches the coast in about 5° S. Lat. In the south the area is bounded by a line extending from Loanda in about 9° S. Lat. through Angola to Katanga and then across the Middle Zambesi to Eastern Rhodesia, whence in about 20° S. Lat. it strikes eastwards as far as Beira. Within this immense area it occurs mainly along watercourses and in marshy depressions, but also enters the bush and forest where open spaces afford sufficient

[1] In Welwitsch, *Cat. Afr. Pl.*, Vol. II. p. 190.
[2] In Hooker's, *Niger Fl.*, p. 563.
[3] Steudel, *Syn. Pl. Glum.*, Vol. I, p. 105.
[4] In *Bolet. Soc. Brot.*, VI (1888), p. 142.
[5] In Peters, *Reise nach Mossamb.*, Vol. VI (1864), p. 552.
[6] K. Schumann in Engl., *Pflanzenw. Ost Afrik.* C. (1895), 105.

light. Under favourable conditions it forms extensive reed jungles, as for instance in the delta of the Zambesi and along the Shire. Even in forests it is locally "only too common," as Welwitsch puts it. In the interior of Sierra Leone it ascends nearly to 900 m., and near its southern limit in the Melsetter district of Rhodesia to 1,800 m., whilst in the Cameroons it is said to reach even the upper limit of woods. It is in rich marshland where it attains to a height of 7 m. and even more, whilst on drier soil, as in the savannas of East Africa, its culms are hardly more than 2 m. high. It also appears occasionally on abandoned cultivated land and has, in a few cases, been observed in a state of cultivation.[1]

Vernacular names.

It is not surprising that a grass of so wide a distribution and striking appearance should have special names in many of the native dialects of Africa. The following is a list, compiled from publications and collectors' notes:—

Togo: Adá: 'Elephanten grass' of German colonists.

Southern Nigeria: Esun funfun (Dodd); Esun (Millen); Esu pupu (MacGregor).

Belgian Congo. Lower Congo: Madiadi (Laurent); Ubanzi District, Mokango: Songo Songo (Bouckenaert); Yakoma: Awors (quoted by De Wildeman). Bangala District, Nouvelle Anvers: Sosongo, Libwakanike (De Giorgi). Territory of Rusisi Kivu: Matete (quoted by De Wildeman); Baraka: Mabingobingo (Dohet). Katanga: Dilenge (Verdick).

Angola: Mariango, Marianga, Marianko (Welwitsch, Buchner, Pogge), Massango (Welwitsch), Malenge-lenge, Malanga (quoted by Leeke).

Uganda, Madi: Maweengo-weengo (Grant).

Usambara: Mbulu, Nguhu (Holst).

Rhodesia, Gutu: Zinyanmuga (Kenny), marabagunda,* dumbamunga (Napier), miraba munga (Mundy).

[1] Kaiser, Acc. to *Just's Jahresber.*, 1898, Vol. I, p. 561.

* M'ramba munga in the report, reproduced on p. 544.

Uses.

Of the stems of the grass, Grant[1] reports: "The tall fences surrounding the residences of the Waganda King and people are of this useful reed; the interiors of all Waganda houses are walled into compartments by it. A strip from it is so sharp that it is used for cutting up meat, and also cutting into fragments the victims of the King of Uganda."

The first mention of *P. purpureum* as a fodder grass is in Schinz, *Plantæ Menyharthianæ*[2] (1905), where the grass is stated to be good fodder for cattle. The note refers to an observation by Menyharth, a Hungarian missionary who from 1889 or 1890 to about 1894 collected in the neighbourhood of Bomma, not far from the Zambesi in the Eastern part of North-west Rhodesia. A remark to the same effect, *Species bovibus nutrimentum maxime idoneum*, by Leeke[3] (1907) rests on the authority of Herr Deistel, Government Gardener in the Cameroons, and Pilger in Engler, *Pflanzenwelt Afrika*[4] (1908), describes it as one of the best fodder grasses.

Independently of those sources, Mr. E. G. Kenny, Native Commissioner, Gutu, and Col. Napier, of Springs, Bulawayo, called the attention of the Agricultural Department of Rhodesia to the value of the grass as a fodder plant.[5] They first noticed it about 1908, "growing in the Gutu district in native lands and being used, as the natives explained, as a muti, or mushonga, to make the other crops grow". It was not growing wild there, and its origin was stated to be doubtful, but Mr. Swynnerton[6] states that it grows in the Melsetter district, about 80 miles south-west of Gutu. Col. Napier has experimented with it, and a short account of his experiences, including a chemical analysis of the grass by the Chemist of the Rhodesian Agricultural Department, was published

[1] Quoted by Oliver in Bot. Speke and Grant Exped. in *Trans. Linn. Soc.*, Vol. XXIV, p. 172.

[2] In *Denkschr. Ak. Wiss. Wien*, Vol. LXXVIII, p. 400.

[3] Leeke, *Abstamm. u. Heimat. d. Negerhirse*, p. 48.

[4] In Engler, *Pflanzenwelt Africas*, Vol. II, p. 145.

[5] *Rhoden. Agri. Jour.*, Vol. VII, p. 1398.

[6] *See* Rendle in *Journ. Linn. Soc.*, Vol. XL, p. 231.

in the "Rhodesian Agricultural Journal" for 1909-1910, from which the following paragraphs are taken :—

(p. 1398.) "Like pearl millet it is reported to be an extremely good drought resister. (p. 1399.) Col. Napier and Mr. Kenny both state that it remains green on dry land late into the autumn and withstands frost to a remarkable degree. Col. Napier has tested it under most severe conditions and is firmly convinced of its economic value. He has now several acres planted on vlei ground on the Central Estates, and is hopeful that in spite of frost it will afford green feed late into the winter. Both cattle and horses eat it readily.*

"Like sugarcane the plant may be propagated either by subdivision of the roots or from cuttings or slips. It roots freely and is reported to grow rapidly after each cutting, thereby enhancing its value as a soiling crop. It seems probable therefore that in Napier's fodder we have found a hardy perennial plant of considerable value for winter feed and suitable for planting on light dry soil.

Chemical analysis.

"The Agricultural Chemist of this Department has made the following analysis of a mature stalk of Napier's fodder which arrived at the laboratories in a partially dried condition, showing that it is comparable in feeding value to maize stalk roughage :—

	Per cent.
Water	55·33
Ether extract	0·84
Protein	3·10
(Total nitrogen converted to equivalent in protein.)	
Carbohydrates	21·16
Fibre	15·66
Ash	3·71
	100·00
Ether extract with chlorophyll removed therefrom ..	0·57
True protein	2·11 "

* Col. Napier has formed so high an opinion of this crop that it is certainly worth a trial in other parts of Southern Rhodesia, and through his co-operation this department is able to offer a limited number of roots f. o. r. Gwelo, under the usual terms of co-operative experiments.

Since then another analysis was made from material grown on the Botanical Experiment Station,* Salisbury; and this together with an analysis of sugarcane from the same station is reproduced below, with the permission of the Agricultural Department, Salisbury, Rhodesia.

"Composition of sugarcane fodder (*Saccharum officinarum*) and Zinvamunga fodder (M'ramba munga or Napier's fodder *Setaria* sp. or *Pennisetum* sp. ?) grown on the Botanical Experiment Station, Salisbury.

Particulars of planting, etc.

	Sample for analysis			
	Time planted	Collected	Length of stalk in feet	Length of leaf in feet
Sugarcane	January 1910	July 1911	2	4
Zinyamunga	March 1910	„ „	8	2

"The fodder had not been cut since planting.

Analysis.

	Sugarcane fodder	Zinyamunga fodder
	Per cent.	Per cent.
Water	73·63	61·81
Ether extract	0·22	0·29
Protein (Nitrogen × 6·25)	1·27	2·92
Carbohydrates	17·73	17·29
Woody fibre	5·32	14·77
Ash	1·83	2·92

*Communicated to Kew in December 1911.

"The amount of juice expressed from stripped stalks by passage between the steel rollers of an ordinary flattening mill used for rolling out metals was in each case as follows:—

	Sugarcane stalks	Zinyamunga stalks
	Per cent.	Per cent.
Juice expressed	56·6	21·3

"The juice of Zinyamunga was tasteless and of low sugar content, whilst that of sugarcane was sweet and contained 6·69 per cent. sucrose (cane sugar) and 2·84 per cent. glucose."

No analyses of the ash were made at Salisbury, but this gap is fortunately supplemented by Dr. F. Zeller,[1] of Victoria, Cameroons, who considers the rotting grass as well as its ash a very valuable manure; and this may actually be the meaning of the statement of the Gutu natives that they plant it "to make the other crops grow". According to him 100 kilogram of dried grass with a water content of 10 per cent. contain:—

1·3 kilogr.	N	corresponding to 6·5 kilogr.	sulphate of ammonia.
2·02 ,,	K_2O	,, ,, 4·0 ,,	chloride of potassium.
0·38 ,,	P_2O_5	,, ,, 1·9 ,,	superphosphate.
0·07 ,,	CaO		
0·1 ,,	MgO		

The best method of propagating the grass is probably by dividing the clumps or from cuttings. No mature seeds have come to hand so far. Searching the ample material of *P. purpureum* at Kew I came across one grain only, and this was not quite mature. Whether this means that the grass actually seeds rarely, or whether it may be that the grains escaped the collectors owing to the extreme readiness with which the spikelets with their involucres detach themselves, I am unable to say.

[1] *Tropenpfl.*, Vol. XV (1911), p. 357.

Notes

FIELD TRIALS WITH ARTIFICIAL FARMYARD MANURE.

EXHAUSTIVE investigations have been carried out at the Rothamsted Experimental Station by Richards and Hutchinson to perfect a process whereby straw could be converted into farmyard manure without the agency of live-stock. Mr. G. H. Garrad gives in "The Agricultural Gazette and Modern Farming" (Vol. XCVIII. p. 791) an account of the testing of this process on some stacks of straw under ordinary farm conditions, and the subsequent utilization of the artificial farmyard manure.

The stacks were built in the following manner: Straw was laid down to the depth of about one foot and on this was sprinkled powdered chalk, the straw then being sprayed with water until saturated. This was continued until the stack was ten feet high, when neutral sulphate of ammonia was applied on the top and well washed in until it had thoroughly penetrated the stack.

In the course of a few days the temperature of the stack had risen, and after about three months the straw had broken down into a brown humus, very much like ordinary farmyard manure.

The treatment of 32 tons of straw was carried out in June 1922 on a farm in the Romney Marsh, and five months later the resulting artificial farmyard manure, and also some bullock dung from the same farm, were analysed, the results being as follows:

	Artificial farmyard manure	Bullock manure
	Per cent.	Per cent.
Nitrogen	0·48	0·37
Phosphate (as tri-calcic) ..	0·16	0·27
Potash	0·27	0·21
Organic matter ..	12·60	11·10

Field trials were then carried out with oats to compare the values of both manures, adjustments being made so that equal quantities of nitrogen, phosphate and potash were given to each plot.

The resulting yields of spring oats were :—

		Grain		Straw
		Qrs.	bus.	Cwt.
Plot 1.	Art. farmyard manure + artificials ..	6	6	36¼
,, 2.	Art. farmyard manure only ..	6	2	32
,, 3.	Bullock dung from manure heap ..	5	6	31¼
,, 4.	Rough and dry dung from yard ..	4	6	32¾
,, 5.	Straw + artificials	4	2	28½

If the straw is not uniformly treated, patches will remain unrotted; however, such straw can be thrown on the next stack and retreated. An improved method has recently been devised which, it is claimed, makes a more uniform product, at a lower cost than that described above. It has been found that 1 ton of straw will make about 3 tons of artificial farmyard manure, the cost of treatment being about 7*s.* per ton of rotted manure. [*Int. Rev. of Sci. and Prac. of Agri.*, N. S., Vol. II, No. 1.]

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THE STRUCTURE OF THE COTTON HAIR.

Dr. W. L. Balls has published in "The Empire Cotton Growing Review" (Vol. I, No. 2, April 1924) the lecture he delivered before Section K of the British Association at Liverpool upon the structure of the cotton hair, reproducing at the same time a number of the fine photographs taken at the Laboratory of the Fine Cotton Spinners' and Doublers' Association, Rock Bank, Bollington, near Macclesfield, with which it was illustrated. Dr. Balls gives a fascinating account, as little technical as the subject permits, of the extraordinary interesting conclusions as to the structure of the cotton hair, and therefore as to the structure of a fairly typical plant cell wall, reached as the result, in great part, of the long series of researches carried out in this laboratory by himself and his colleagues.

The cotton hair is a single epidermal cell of the cotton ovule, which extends in length while still within the boll, for some 25–30 days, and then for about another 30 days thickens by successive deposits of cellulose, the daily rings of growth predicted and afterwards discovered by Balls, here beautifully illustrated by photographs both of crushed and sectional hairs. When the boll opens, the hair collapses as it dries into a long flattened tube, with many spiral convolutions frequently reversing in direction along its length. Dr. Balls has now shown that these are to be associated with the longitudinal "pit" spirals, also reversing at intervals, which are found accurately superposed in every successive layer of wall thickening, so that the ultimate structural unit of the wall would seem to be one of these spiral fibrils, whilst the position of this in the wall in every layer would seem to be predetermined in some way by the structure of the original wall of the unthickened hair. This spiral pattern has, however, not yet revealed itself in this original wall, although by special treatment Dr. Balls has demonstrated a twinned, slower "slip" spiral, so called because it coincides in angle with the cleavage surfaces developed in the hair under stress. The "pit" spirals are so named because the long axis of the oval pits in the cell wall coincides with the pitch of this more rapid spiral, so that the pits seem to arise by partial divergence from one another of two contiguous spirals (a divergence which is repeated through successive daily layers of wall). It is very suggestive that there are, in a single adult hair, in the neighbourhood of thirty complete reversals of the "pit" spiral, a hint, as Dr. Balls remarks, that each reversal may represent a day's growth in length, though an intriguing footnote states that further research has shown this "guess to be largely wrong, but the true story even more interesting".

Some day the structural unit, the spiral running fibril, has to be associated with one of the main chemical units concerned, the cellulose molecule. It is extremely suggestive that the pit spiral and slip spiral structures have largely been elucidated with the aid of polarised light, and that the optical axis of the wall is determined by the direction of the pit spiral, so that the chemical molecules are

presumably definitely orientated in the pit spiral. One extraordinarily important biological and technical result that emerges is that structurally the cotton hair wall is a wonderfully organized sponge, in which a relatively dense cellulose framework provides an enormous surface and is interpenetrated in nature presumably by an aqueous medium in which important diffusion, adsorption, and chemical processes are proceeding. [*Nature*, No. 2851.]

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VITAMINS, SUCCULENCE, AND PRICKLY PEAR.

In a vigorously written Bulletin, Reprint 43, 1923, of the South African Department of Agriculture, Mr. A. Stead, Senior Chemist, Division of Chemistry, connects the above three factors, on grounds rather of interpretation of the community's experience than of experiment. Pointing out the value of succulent fodder to cattle, he concludes that this is due to its content of vitamin A, and then deduces from the healthy cattle (and human population) carried by the Karroo, in spite of the absence of grass, that such plants as prickly pear and the American aloe, *Agâve Americana*, must be storehouses of vitamin A. Hence follows a vigorous plea to regard the prickly pear in another light than as South Africa's widespread pest, and the experience of representative farmers is cited for its value as cattle food when pulped, whilst where brushwood abounds, the spines can be dealt with by singeing over a brushwood fire. [*Nature*, No. 2846.]

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SISAL HEMP PRODUCTION IN THE EMPIRE.

Sisal hemp is chiefly produced in Mexico, where the annual output is about 150,000 tons. More than nine-tenths of this goes to the United States, where it is employed for the manufacture of the binder twine used in harvesting the immense grain crops of the Western States, the demand for binder twine for this purpose amounting to about 200,000,000 lb. annually. It is obvious, therefore, that European buyers must look to countries other than Mexico for adequate supplies of the fibre.

A useful résumé of the present position of sisal hemp cultivation in the British Empire is given in the current (July 1924) issue of the "Bulletin of the Imperial Institute," just published by Mr. John Murray. East African sisal, produced in Tanganyika and Kenya Colony, is of excellent quality and large quantities come to the British market, where it realizes prices higher than those of Mexican sisal. The Bahamas also grow the fibre on a fairly extensive scale, but the whole of their output is taken by the United States. No other country in the Empire is at present producing large quantities of the fibre, but commercial supplies may be expected in the near future from Ceylon, Nyasaland, Gold Coast, Mauritius and Jamaica. Several other regions are well adapted to the crop and have extensive areas available for cultivation.

PERSONAL NOTES, APPOINTMENTS AND TRANSFERS, MEETINGS AND CONFERENCES, ETC.

DR. HAROLD H. MANN, D.Sc., Director of Agriculture, Bombay, has been allowed by the High Commissioner for India an extension of leave for 14 days.

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RAO SAHEB T. S. VENKATRAMAN, B.A., Government Sugarcane Expert, Coimbatore, has been granted leave for 6 weeks from or after 23rd June, 1924.

***

MR. N. S. KOLANDASWAMI PILLAI, Deputy Director of Agriculture, Fifth Circle, Madras, has been reverted as Assistant Director of Agriculture from 15th July, 1924, but continues in charge of the Fifth Circle.

***

MR. F. H. VICK, Agricultural Engineer to Government, United Provinces, has been granted an extension of leave for 3 months.

***

MR. D. P. JOHNSTON, A.R.C.Sc.I., Deputy Director of Agriculture, Lyallpur, has been granted leave on average pay for 1 month from 23rd June, 1924.

***

MR. T. F. QUIRKE, M.R.C.V.S., Chief Superintendent, Civil Veterinary Department, Punjab, has been granted leave on average pay for 8 months from 1st April, 1924, Mr. R. Branford officiating.

***

MR. T. J. EGAN, M.R.C.V.S., has been appointed to officiate as Superintendent, Government Cattle Farm, Hissar, *vice* Mr. R. Branford on other duty.

On return from his deputation to England, Mr. Karam Elahi took over charge as Professor of Parasitology at the Punjab Veterinary College on 31st May, 1924.

***

Srijut Lakheswar Barthakur has been appointed Special Officer to make preliminary enquiries in connection with the improvement of cattle-breeding in Assam for a period of 6 months from 1st July, 1924.

Review

Butterflies of India.—By C. B. Antram. Pages xvi + 226, 418 figures + 2 plates. [Calcutta, May 1924; Thacker, Spink & Co.] Price, Rs. 30.

According to the author's preface, "the chief object of this work has been to show an illustration of every species described... with a view to .... identification of the different forms," and, so far as it goes, this book will assist the beginner to give names to most of his captures, as the figures are good and well-produced, and the descriptions, albeit brief, bring out the salient characters of the species dealt with.

Butterflies have long been favourites of amateur entomologists in India and during the last century masses of descriptions, illustrations and notes on these insects have been published, but a large proportion of this literature is scattered throughout various scientific periodicals and hence inaccessible to the amateur. An unfortunate fate seems to have dogged every attempt to produce hitherto any complete book on Indian Butterflies. Three volumes were issued by Marshall and de Niceville before the death of the latter. Moore did not live to see the completion of his great work "Lepidoptera Indica," which was carried to its conclusion by Swinhoe; this is the only reasonably complete work on Indian Butterflies, in ten volumes, with coloured figures of all the species, but, as the complete work costs about £80, it is beyond the reach of most collectors. Bingham died after issuing two volumes in the *Fauna of British India* series and, after a lapse of about twenty years, two more volumes, to complete the series, are now in preparation. Young commenced a series of papers on common butterflies in the *Bombay Natural History Society's Journal*, but this also was interrupted by his death; this series was recommenced by Bell and is still continuing.

All of these publications are now practically unobtainable and hence there is a distinct gap which Mr. Antram's book will do something to fill, so far as it goes. It does not, however, go far enough. From the title the prospective purchaser assumes that it deals with all the Indian Butterflies, but this is very far from being the case as we find only 512 species enumerated out of a total of thrice as many, the two large Families of the "Blues" and the "Skippers" being wholly omitted. The term "India" is also used in a restricted sense to exclude Burma and Ceylon.

A decided improvement would have been the inclusion of keys to the Families and Genera. As it is, the collector who wishes to name his captures has to plough through the book until he hits on a Figure which seems appropriate. To the advanced student, who can generally tell at least approximately the relationships of his specimen, this matters less, but to the beginner, for whom this book appears to be intended, the absence of any indication of where to look entails a good deal of unnecessary trouble.

As the author states that he has been collecting butterflies in India for over twenty years, it is a pity that he has not found occasion or space to give his readers any observations on the habits of the species dealt with. Another notable omission is any reference to the caterpillars except extremely occasional and brief notices of food-plants. Many butterflies are most easily obtained as caterpillars and reared out, whilst observation of their habits and structure during their early stages gives an added interest to specimens so obtained.

A few minor errors require correction, e.g., *Lantana* for "Lanterna" on p. 5. *Papilio sikkimensis* (not *sikhimensis* as here written, p. 10) is of course only a form of the European *P. machaon*, which occurs from the North-West Frontier to North Burma. *Parnassius jacquimonti* is mis-written on pages 35, 213, 222 for *jacquemonti*, the name being derived from that of the author of the well-known "Voyage dans l' Inde, 1828–32". *Pieris brassicæ* (p. 46) occurs commonly in North Bihar in the Spring and this year it was abundant at Shillong, where it seems to be a recent immigrant. In figure 103 the sex signs required to be transposed. *Lethe yama*

(p. 95), in the form *yamoides*, which is not mentioned in this book, occurs in the Khasi Hills not uncommonly.

To those who have not access to the "Fauna" volumes or "Lepidoptera Indica," this book will doubtless be useful, so far as it goes. It is compact and of a handy size to carry about when on collecting trips. [T. B. F.]

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1. Soil Management, by Firman E. Bear. Pp. 268. (London: Chapman and Hall, Ltd.) Price, 10*s*. net.
2. The Production of Field Crops. A Textbook of Agronomy, by T. B. Hutcheson and T. K. Wolfe. Pp. xv+499. (London: McGraw-Hill Publishing Co.) Price, 17*s*. 6*d*. net.
3. Dairy Farming Projects, by Carl Edwin Ladd. Pp. xix+327. (London: Macmillan and Company.) Price, 7*s*. 6*d*. net.
4. Agriculture: The Science and Practice of British Farming, by J. A. S. Watson and J. A. More. Pp. 666+30 plates. (Edinburgh and London: Oliver and Boyd.) Price, 15*s*. net.
5. Modern Farm Machinery, by D. N. McHardy. Pp. 255. (London: Methuen and Company.) Price, 7*s*. 6*d*.
6. Manual of Cultivated Plants, by L. H. Bailey. Pp. 851. (London: Macmillan and Company.) Price, 31*s*. 6*d*.
7. Rice, by E. B. Copeland. Pp. xiv+352+18 plates. (London: Macmillan and Company.) Price, 20*s*. net.

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1. Studies in Indian Fibre Plants. No. 3. On the Inheritance of Characters in *Hibiscus Sabdariffa* L., by Albert Howard, C.I.E., and Gabrielle L. C. Howard, M.A. Price, Rs. 2 or 3*s*.

Bulletin.

2. The Bionomics of the Sarcopic Mange Parasite of the Buffalo with some observations concerning the relative power of resistance to adverse conditions of the different stages of the Acarus and of its egg, by T. M. Timoney, M.R.C.V.S. Price, As. 2.